Honeywell

User Manual

SmartVFD HVAC

Variable Frequency Drives for Constant and Variable Torque Applications

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INDEX

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1. SAFETY

This manual contains clearly marked cautions and warnings which are intended for your personal safety and to avoid any unintentional damage to the product or connected appliances.

Please read the information included in cautions and warnings carefully.

The cautions and warnings are marked as follows:

	= DANGEROUS VOLTAGE!
	= WARNING or CAUTION

Table 1. Warning signs

1.1 Danger

	The **components of the power unit of the Smart VFD HVAC are live** when the drive is connected to mains potential. Coming into contact with this voltage is **extremely dangerous** and may cause death or severe injury.
	The **motor terminals U, V, W and the brake resistor terminals are live** when the drive is connected to mains, even if the motor is not running.
	After disconnecting the drive from the mains, **wait** until the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait 5 more minutes before doing any work on the connections of the drive. Do not open the cover before this time has expired. After expiration of this time, use a measuring equipment to absolutely ensure that no voltage is present. **Always ensure absence of voltage before starting any electrical work!**
	The control I/O-terminals are isolated from the mains potential. However, the **relay outputs and other I/O-terminals may have a dangerous control voltage** present even when the drive is disconnected from mains.
	Before connecting the drive to mains make sure that the front and cable covers of the drive are closed.
	During a ramp stop (see the Application Manual), the motor is still generating voltage to the drive. Therefore, do not touch the components of the drive before the motor has completely stopped. Wait until the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait additional 5 minutes before starting any work on the drive.

1.2 Warnings

⚠	The Honeywell Smart VFD HVAC is meant for **fixed installations only**.
⚠	**Do not perform any measurements** when the drive is connected to the mains.
⚠	The **touch current** of the Honeywell Smart VFD HVAC exceeds 3.5mA AC. According to standard EN61800-5-1, **a reinforced protective ground connection** must be ensured. See chapter 1.3.
⚠	If the drive is used as a part of a machine, the **machine manufacturer is responsible** for providing the machine with a **supply disconnecting device** (EN 60204-1).
⚠	Only **spare parts** delivered by Honeywell can be used.
⚠	At power-up, power brake or fault reset **the motor will start immediately** if the start signal is active, unless the pulse control for Start/Stop logic has been selected. Futhermore, the I/O functionalities (including start inputs) may change if parameters, applications or software are changed.Disconnect, therefore, the motor if an unexpected start can cause danger.
⚠	The **motor starts automatically** after automatic fault reset if the autoreset function is activated. See the Application Manual for more detailed information.
⚠	**Prior to measurements on the motor or the motor cable**, disconnect the motor cable from the drive.
⚠	**Do not touch the components on the circuit boards**. Static voltage discharge may damage the components.
⚠	Check that the **EMC level** of the drive corresponds to the requirements of your supply network. See chapter 5.2.
⚠	In a domestic environment, this product may cause radio interference in which case supplementary mitigation measures may be required.

1.3 Grounding and ground fault protection

⚠	**CAUTION!**

The Honeywell Smart VFD HVAC AC drive must always be grounded with an grounding conductor connected to the grounding terminal marked with ⏚.

The touch current of the drive exceeds 3.5mA AC. According to EN61800-5-1, one or more of the following conditions for the associated protective circuit shall be satisfied:

1. A fixed connection and
   a) the **protective earthing conductor** has a cross-sectional area of at least 10 mm² Cu or 16 mm² Al through its total run.
   b) an automatic disconnection of the supply in case of loss of continuity of the protective conductor. See chapter 4.

c) provision of an additional terminal for a second **protective earthing conductor** of the same cross-sectional area as the original **protective earthing conductor**.

OR

2. Connection with an industrial connector according to IEC 60309 and a minimum **protective earthing connector** cross-section of 2.5mm² as part of a multi-conductor power cable. Adequate strain relief shall be provided.

NOTE: Due to the high capacitive currents present in the drive, fault current protective switches may not function properly.

⚠	**Do not perform any voltage withstand tests** on any part of the drive. There is a certain procedure according to which the tests shall be performed. Ignoring this procedure may result in damaged product.

1.4 Running the motor

MOTOR RUN CHECK LIST

⚠	**Before starting the motor**, check that the motor is **mounted properly** and ensure that the machine connected to the motor allows the motor to be started.
⚠	Set the maximum motor speed (frequency) according to the motor and the machine connected to it.
⚠	**Before reversing the motor** make sure that this can be done safely.
⚠	Make sure that no power correction capacitors are connected to the motor cable.
⚠	Make sure that the motor terminals are not connected to mains potential.

2. RECEIPT OF DELIVERY

Check the correctness of delivery by comparing your order data to the drive information found on the package label. If the delivery does not correspond to your order, contact the supplier immediately. See chapter 2.3.

2.1 'Product modified' sticker

In the small plastic bag included with delivery you will find a silver *Product modified* sticker. The purpose of the sticker is to notify the service personnel about the modifications made in the drive. Attach the sticker on the side of the drive to avoid losing it. Should the drive be later modified mark the change on the sticker.

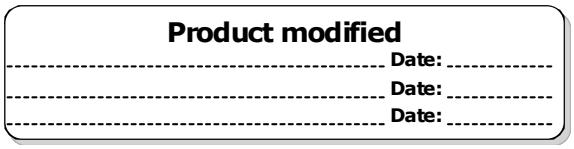


Figure 1. 'Product modified' sticker

2.2 Unpacking and lifting the drive

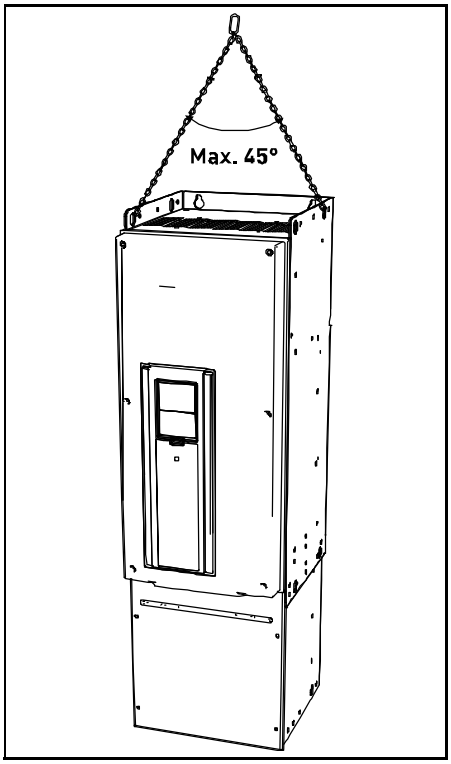
The weights of the drives vary greatly according to the size. You may need to use a piece of special lifting equipment to remove the drive from its package. Note the weights of each individual frame size in Table 2 below.

Frame	Weight [kg]	Weight [lb.]
MR4	6.0	13.2
MR5	10.0	22.0
MR6	20.0	44.1
MR7	37.5	82.7
MR8	70.0	154.3
MR9	108.0	238.1

Table 2. Frame weights

If you decide to use a piece of lifting equipment see picture below for recommendations to lift the drive.

2.2.1 Lifting frames MR8 and MR9



NOTE: Place the lifting hooks symmetrically in at least two holes.The lifting device must be able to carry weight of the drive.

NOTE: The maximum allowed lifting angle is 45 degrees.

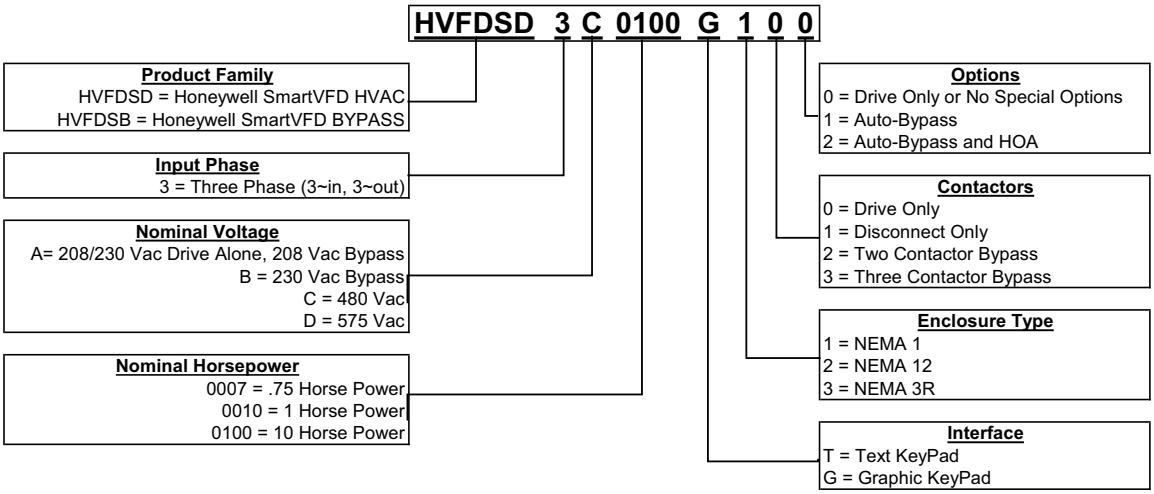
Figure 2. Lifting bigger frames

The Honeywell Smart VFD HVAC undergoes scrupulous tests and quality checks at the factory before it is delivered to the customer. However, after unpacking the product, check that no signs of transport damages are to be found on the product and that the delivery is complete.

Should the drive have been damaged during the shipping, please contact primarily the cargo insurance company or the carrier.

2.3 Type designation code

Honeywell type designation code is formed of a four-segment code. Each segment of the type designation code uniquely corresponds to the product and options you have ordered. The code is of the following format:


HVFDSD 3 C 0100 G 1 0 0
Product Family
HVFDSD = Honeywell SmartVFD HVAC
HVFDSB = Honeywell SmartVFD BYPASS
Input Phase
3 = Three Phase (3~in, 3~out)
Nominal Voltage
A= 208/230 Vac Drive Alone, 208 Vac Bypass
B = 230 Vac Bypass
C = 480 Vac
D = 575 Vac
Nominal Horsepower
0007 = .75 Horse Power
0010 = 1 Horse Power
0100 = 10 Horse Power
Options
0 = Drive Only or No Special Options
1 = Auto-Bypass
2 = Auto-Bypass and HOA
Contactors
0 = Drive Only
1 = Disconnect Only
2 = Two Contactor Bypass
3 = Three Contactor Bypass
Enclosure Type
1 = NEMA 1
2 = NEMA 12
3 = NEMA 3R
Interface
T = Text KeyPad
G = Graphic KeyPad

2.4 Accessories

After having opened the transport package and lifted the converter out, check immediately that these various accessories were included in the delivery:

- Rubber grommets (sizes vary according to frame)
- Power cable clamps for EMC grounding
- Screws for fixing the power cable clamps
- Control cable grounding clamps
- M4 screw for EMC level change in frame MR7
- Additional grounding screw (if necessary, see chapter 1.3)
- Ferrite holder
- Optional plastic shield to prevent unintended contact with live parts from front (MR8 and MR9, IP00)

3. MOUNTING

The drive must be mounted in vertical position on the wall. Ensure that the mounting plane is relatively even.

The drive shall be fixed with four screws (or bolts, depending on the unit size).

3.1 Dimensions

3.1.1 Wall mount, MR4-MR7

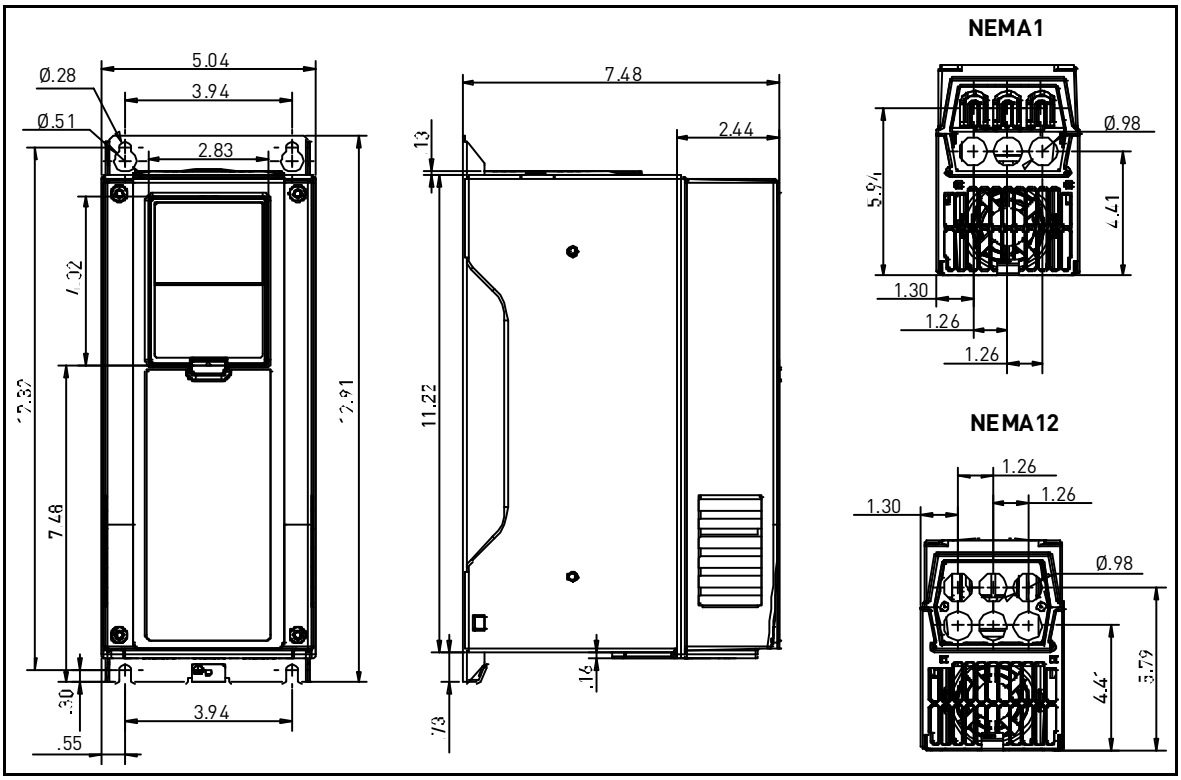


Figure 3. SmartVFD HVAC dimensions, MR4, wall mount

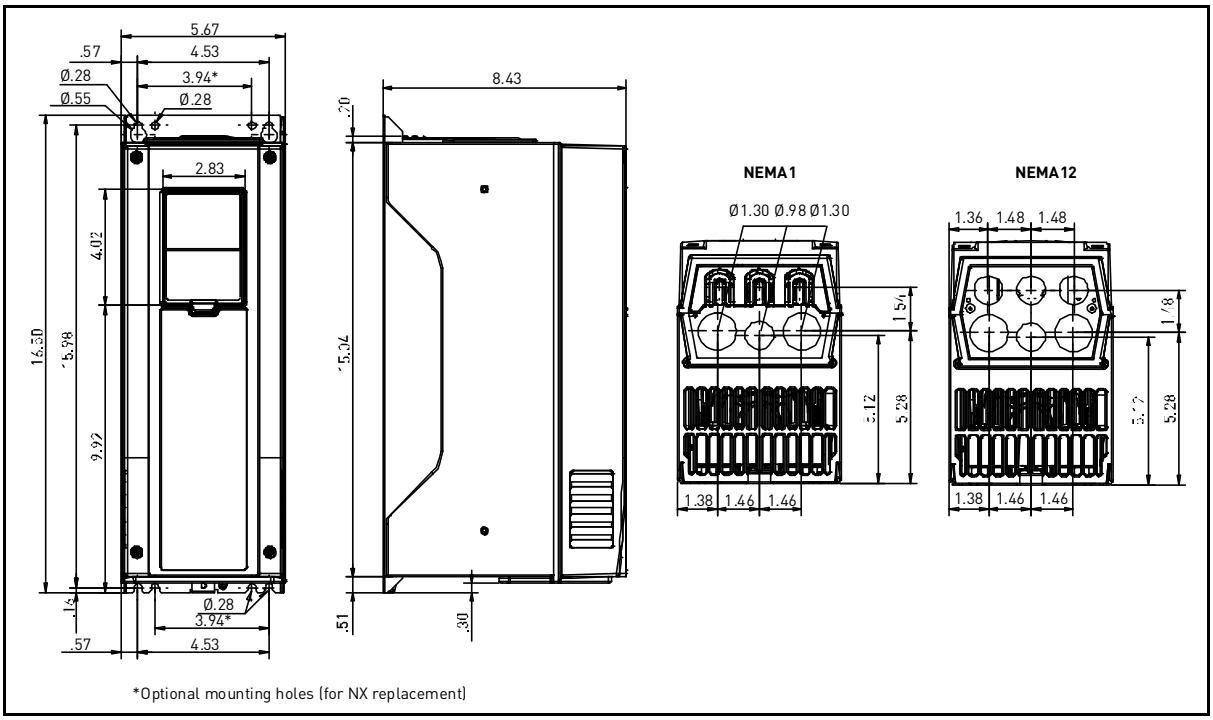


Figure 4. SmartVFD HVAC dimensions, MR5, wall mount

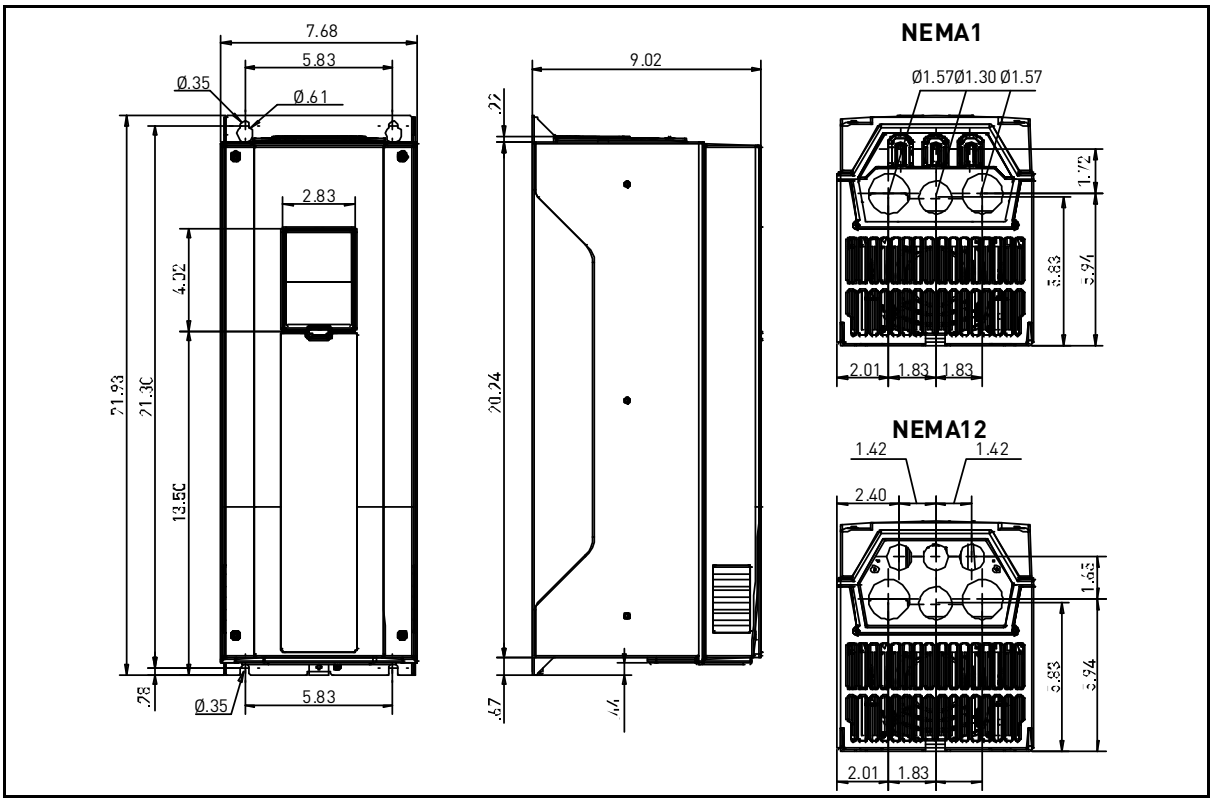


Figure 5. SmartVFD HVAC dimensions, MR6, wall mount

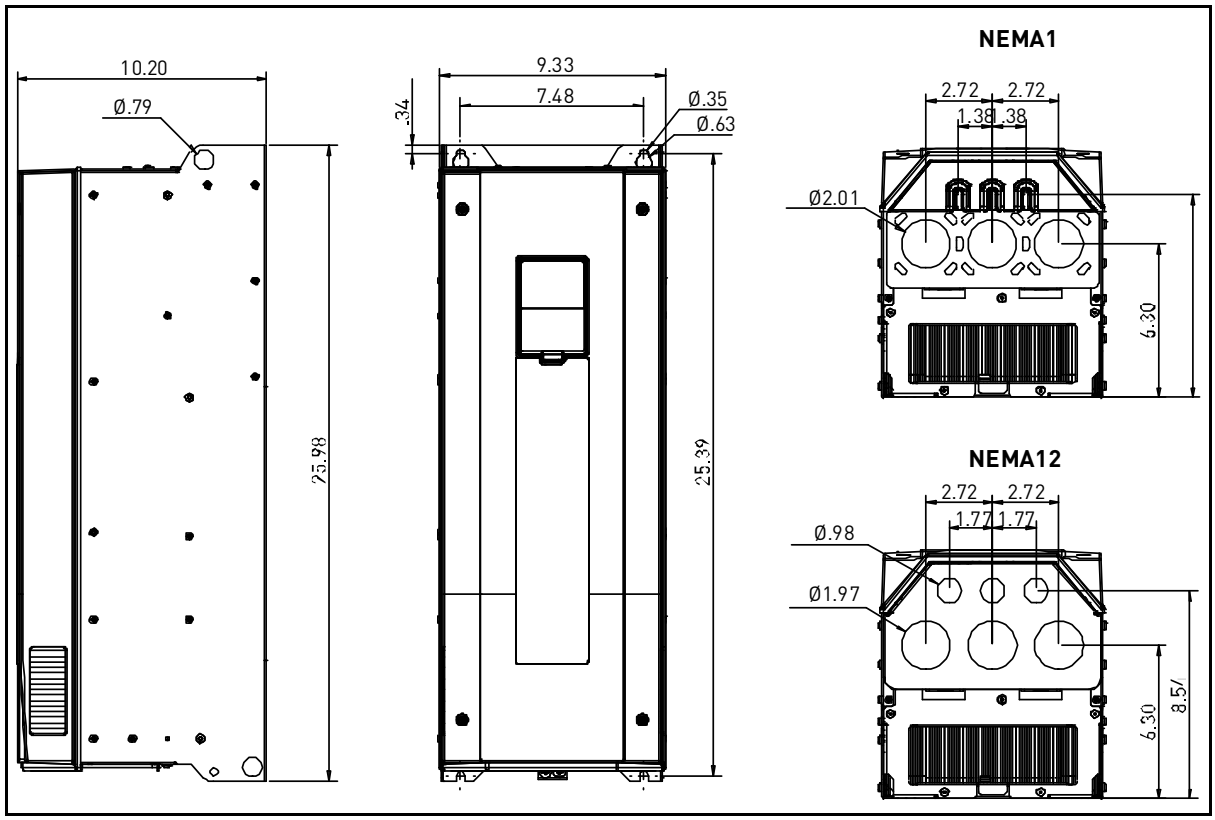


Figure 6. SmartVFD HVAC dimensions, MR7, wall mount

3.1.2 Wall mount, MR8 and MR9

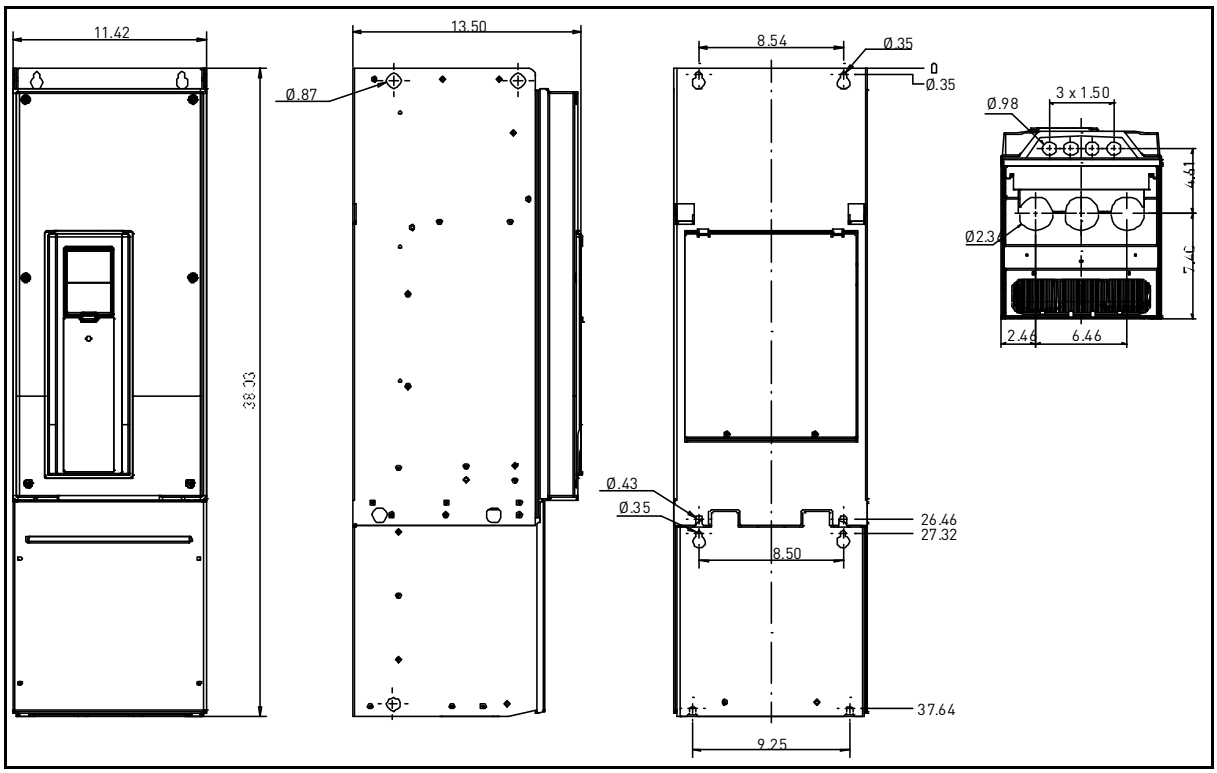


Figure 7. AC drive dimensions, MR8 NEMA1 and NEMA12

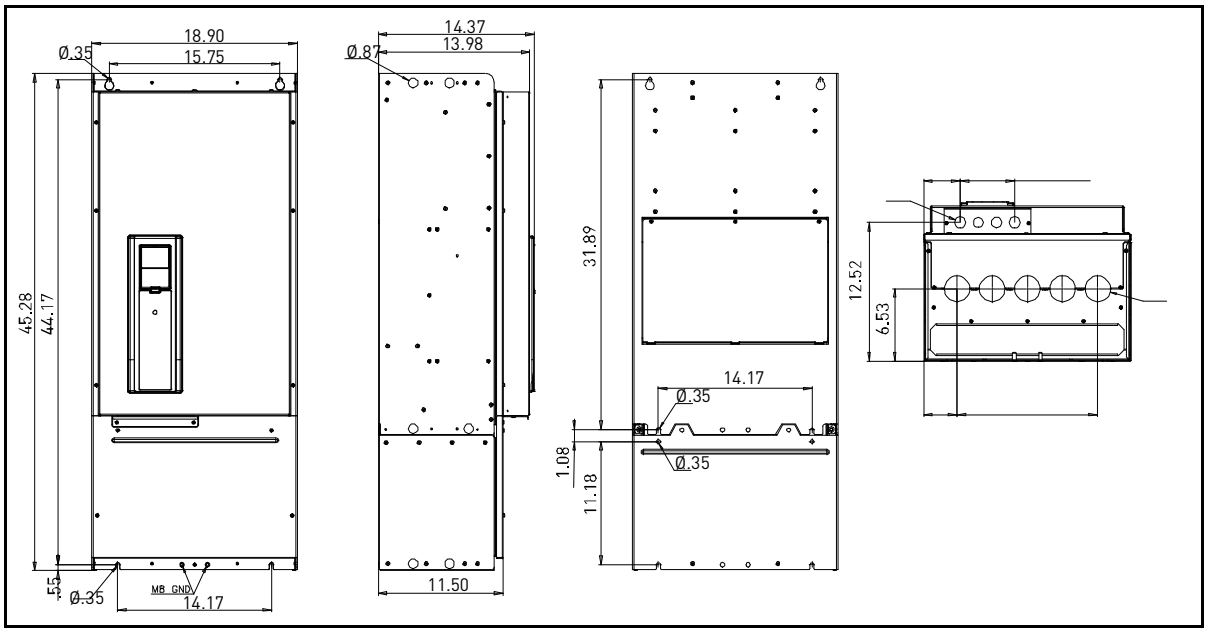


Figure 8. AC drive dimensions, MR9 NEMA1 and NEMA12 (preliminary)

3.1.3 Flush mount

The AC drive can also be recessed into the cabinet wall or similar surface. A special flush mount option is available for this purpose. For an example of a flush-mounted drive, see Figure 9.

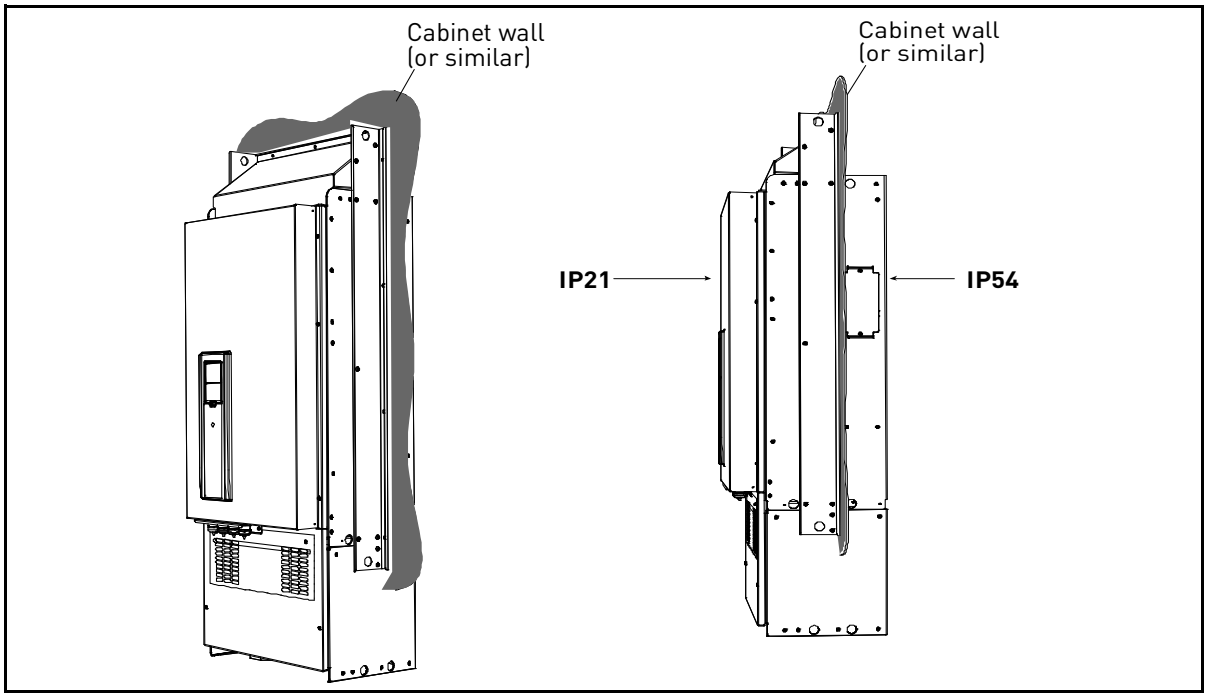


Figure 9. Example of flush mount (frame MR9)

3.1.3.1 Flush mount - Frames MR4 to MR6

Figure 10. presents the dimensions of the mounting opening and Figure 11. the depth dimensions of the drives with the flush mount option.

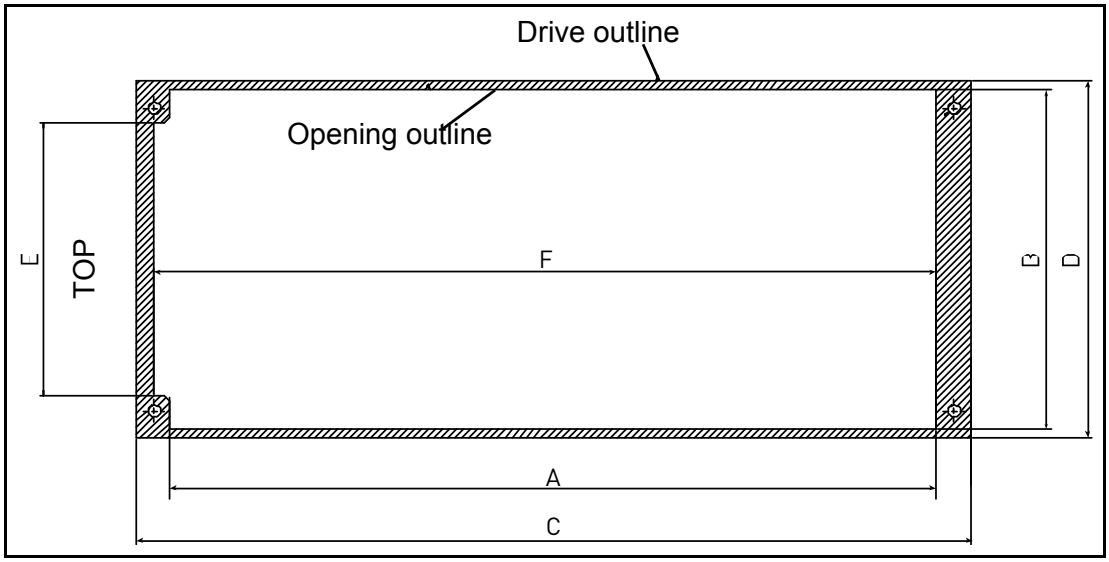


Figure 10. Flush mount cutout dimensions for MR4 to MR6

Frame	A	B	C	D	E	F
MR4	12.20	5.39	13.27	5.67	4.33	12.44
MR5	16.06	5.98	17.09	6.30	5.20	16.30
MR6	21.02	7.99	22.05	8.31	7.24	21.30

Table 3. Flush mount cutout dimensions for MR4 to MR6 [in]

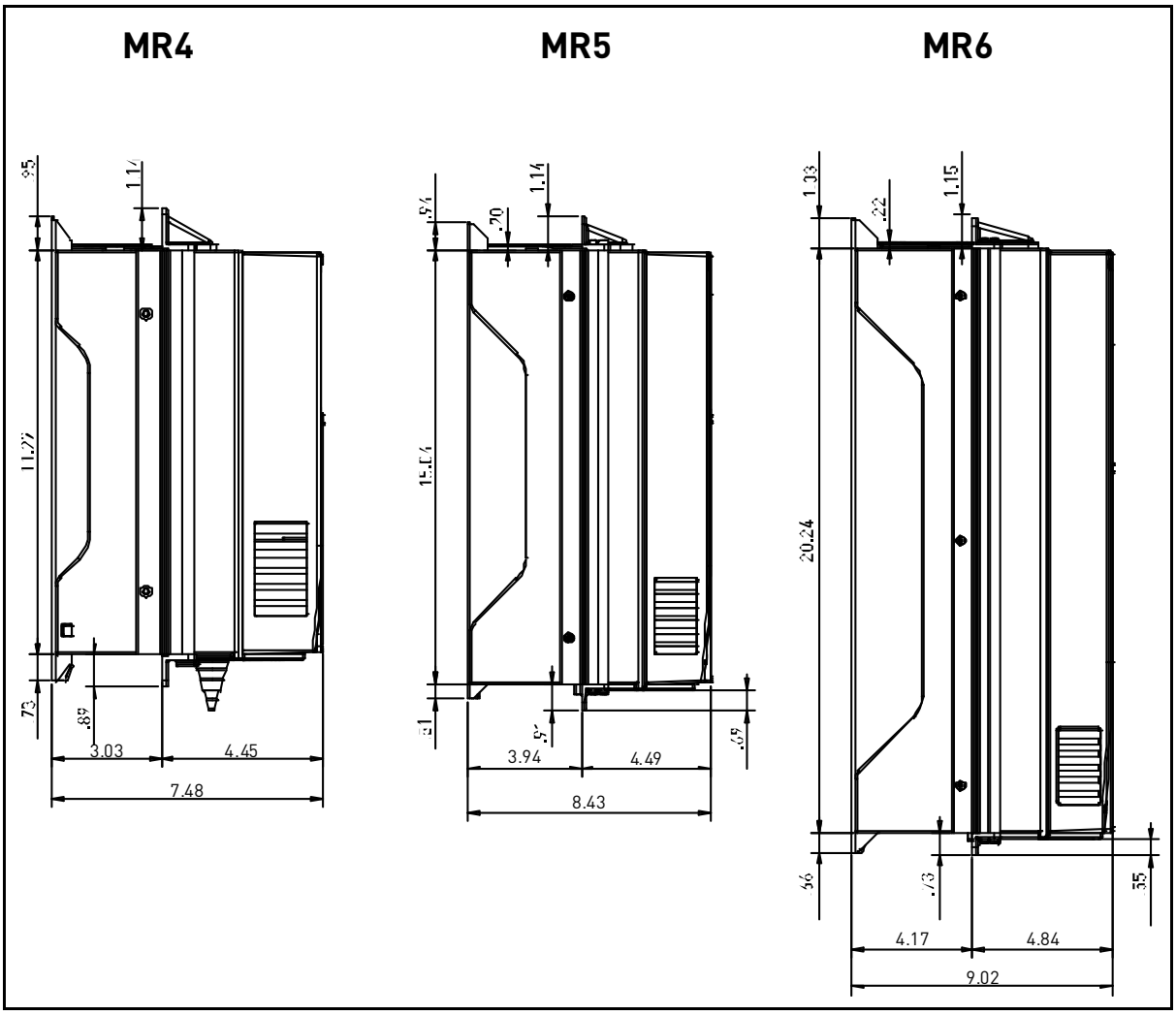


Figure 11. MR4 to MR6, flush mount, depth dimensions

3.1.3.2 Flush mount MR7 to MR9

Figure 12. presents the dimensions of the mounting opening and Figure 13. the dimensions of the drives with the flush mount option.

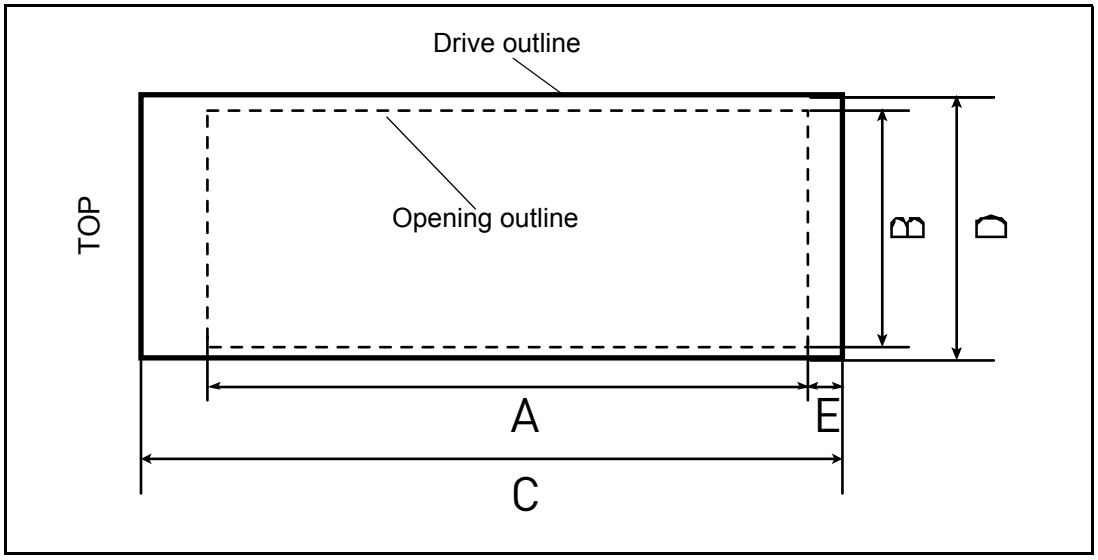


Figure 12. Flush mount cutout dimensions for MR7 to MR9

Frame	A	B	C	D	E
MR7	25.79	9.45	26.85	10.55	.53
MR8	33.82	11.73	34.96	14.13	.67
MR9	38.39	19.09	41.34	20.87	2.13

Table 4. Flush mount cutout dimensions for MR7 to MR9 [in]

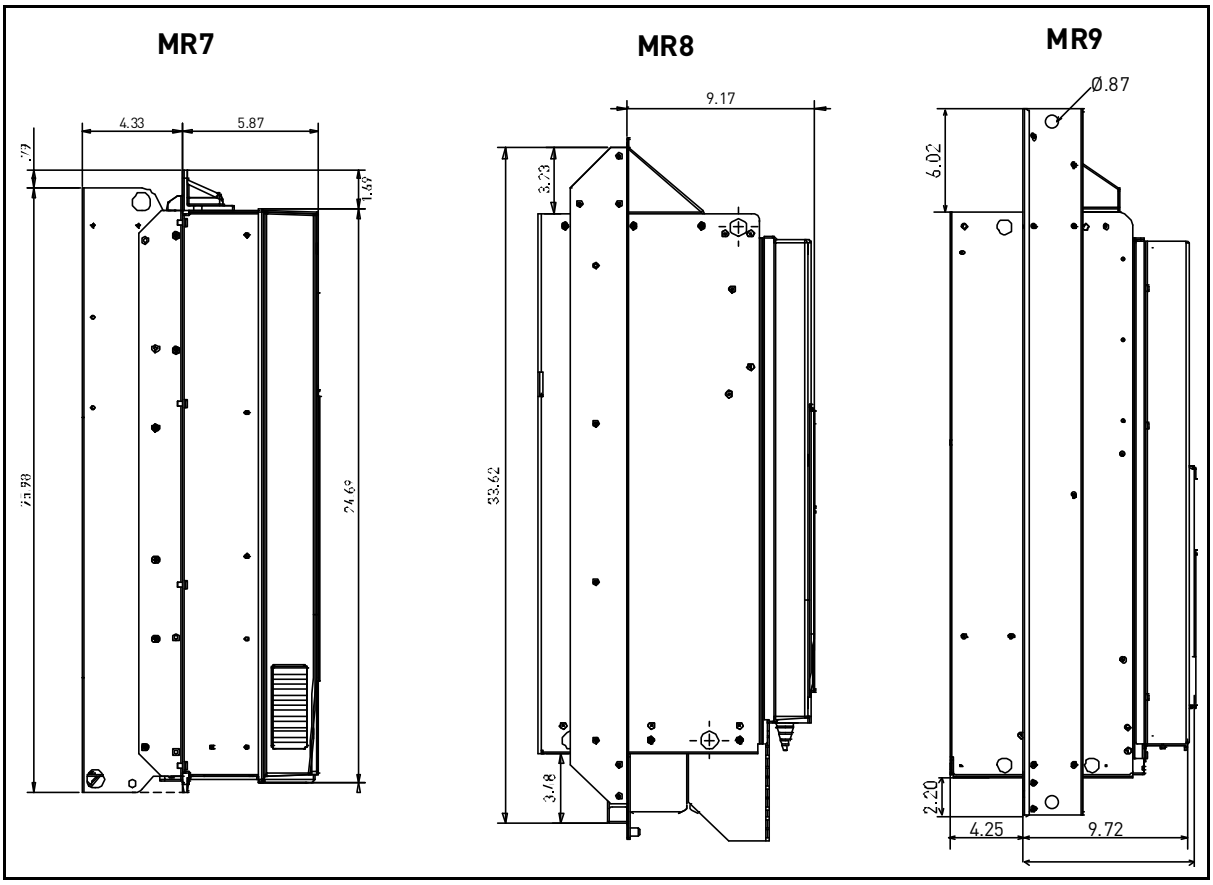


Figure 13. MR7 to MR9, flush mount, depth dimensions

3.2 Cooling

The drive produces heat in operation and is cooled by air circulated by a fan. Enough free space needs to be left around the drive to ensure sufficient air circulation and cooling. Different acts of maintenance also require a certain amount of free space.

Make sure that the temperature of the cooling air does not exceed the maximum ambient temperature of the converter.

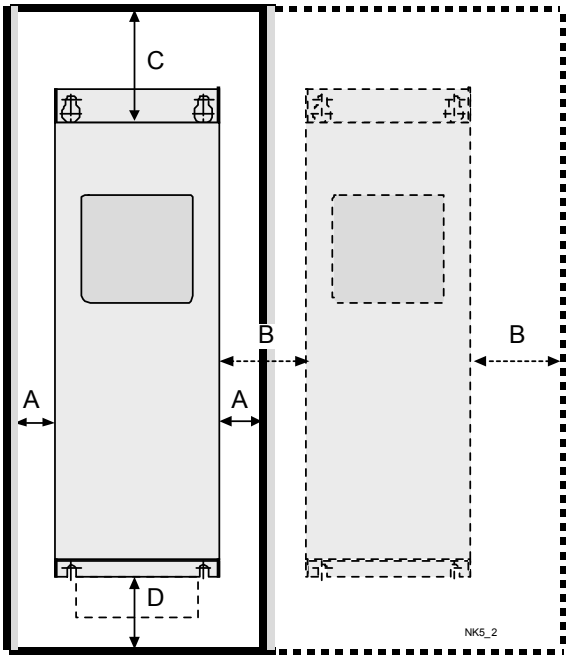


Figure 14. Installation space

Min clearance [in], NEMA1				
Type	**A***	**B***	**C**	**D**
MR4	.79	.79	3.94	1.97
MR5	.79	.79	4.72	2.36
MR6	.79	.79	6.30	3.15
MR7	.79	.79	9.84	3.94
MR8	.79	.79	11.8	5.91
MR9	.79	.79	13.78	7.87

*. Min clearances A and B for drives with IP54 enclosure is 0 in.

Table 5. Min. clearances around drive

A = clearance around the drive (see also B)
B = distance from one drive to another or distance to cabinet wall
C = free space above the drive
D = free space underneath the drive

Note that if several units are mounted above one another the required free space equals C + D (see Figure 15.). Moreover, the outlet air used for cooling by the lower unit must be directed away from the air intake of the upper unit.

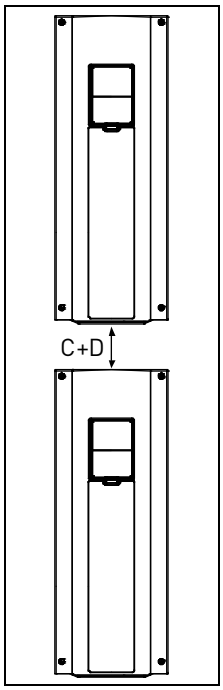


Figure 15. Installation space when drives are mounted on top of each other

Type	Cooling air required [cfm]
MR4	26
MR5	44
MR6	112
MR7	109
MR8	197
MR9	366

Table 6. Required cooling air

4. POWER CABLING

The mains cables are connected to terminals L1, L2 and L3 and the motor cables to terminals marked with U, V and W. See Table 7 for the cable recommmendations for different EMC levels.

Use cables with heat resistance of at least +158°F. The cables and the fuses must be dimensioned according to the drive nominal OUTPUT current which you can find on the rating plate.

Cable type	1st environment 2nd environment EMC levels According to EN61800-3 (2004)		
	Category C2	Category C3	Level T
Mains cable	1	1	1
Motor cable	3*	2	2
Control cable	4	4	4

Table 7. Cable types required to meet standards

1 = Power cable intended for fixed installation and the specific mains voltage. Shielded cable not required. (MCMK or similar recommended).
2 = Symmetrical power cable equipped with concentric protection wire and intended for the specific mains voltage. (MCMK or similar recommended). See Figure 16.
3 = Symmetrical power cable equipped with compact low-impedance shield and intended for the specific mains voltage. [MCCMK, EMCMK or similar recommended; Recommended cable transfer impedance (1...30MHz) max. 100mohm/m]. See Figure 16.
*360º grounding of the shield with cable glands in motor end needed for EMC level C2.
4 = Screened cable equipped with compact low-impedance shield (JAMAK, SAB/ÖZCuY-O or similar).

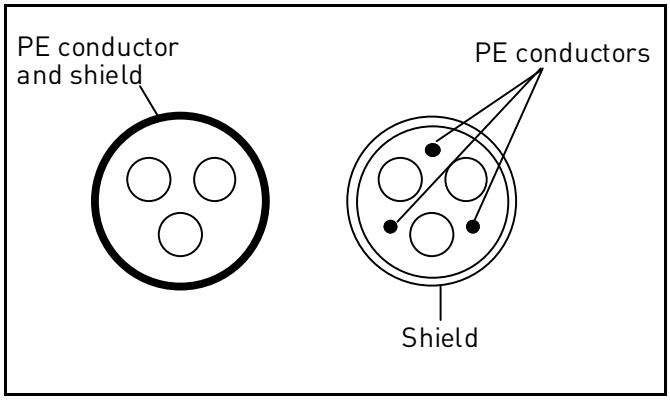


Figure 16.

NOTE: The EMC requirements are fulfilled at factory defaults of switching frequencies (all frames).
NOTE: If safety switch is connected the EMC protection shall be continuous over the whole cable installation.

4.1 UL standards on cabling

To meet the UL (Underwriters Laboratories) regulations, use a UL-approved copper cable with a minimum heat-resistance of +140/167°F. Use Class 1 wire only.

The units are suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 600V maximum.

4.1.1 Cable dimensioning and selection

Table 8 shows the minimum dimensions of the Cu/Al-cables and the corresponding fuse sizes. Recommended fuse types are gG/gL.

These instructions apply only to cases with one motor and one cable connection from the drive to the motor. In any other case, ask the factory for more information.

4.1.1.1 Cable and fuse sizes, frames MR4 to MR6, North America

The recommended fuse types are gG/gL (IEC 60269-1) or class T (UL & CSA). The fuse voltage rating should be selected according to the supply network. The final selection should be made according to local regulations, cable installation conditions and cable specification. Bigger fuses than what is recommended below shall not be used.

Check that the fuse operating time is less than 0.4 seconds. Operating time depends on used fuse type and impedance of the supply circuit. Consult the factory about faster fuses. Honeywell offers recommendations also for high speed J (UL & CSA), aR (UL recognized, IEC 60269-4) and gS (IEC 60269-4) fuse ranges.

Frame	Type*	I_L [A]	Fuse (class T) [A]	Mains, motor and ground cable Cu	Terminal cable size	
					Main terminal	Ground terminal
MR4	C 0015	3.4	6	AWG14	AWG24-AWG10	AWG17-AWG10
	C 0020	4.8	6	AWG14	AWG24-AWG10	AWG17-AWG10
	C 0030	5.6	10	AWG14	AWG24-AWG10	AWG17-AWG10
	C 0050	8.0	10	AWG14	AWG24-AWG10	AWG17-AWG10
	C 0075	12.0	20	AWG14	AWG24-AWG10	AWG17-AWG10
MR5	C 0100	16.0	25	AWG10	AWG20-AWG5	AWG17-AWG8
	C 0150	23.0	30	AWG10	AWG20-AWG5	AWG17-AWG8
	C 0200	31.0	40	AWG8	AWG20-AWG5	AWG17-AWG8
MR6	C 0250	38.0	50	AWG4	AWG13-AWG0	AWG13-AWG2
	C 0300	46.0	60	AWG4	AWG13-AWG0	AWG13-AWG2
	C 0400**	61.0	80	AWG4	AWG13-AWG0	AWG13-AWG2

*. For more information on type code, see page 8.
**. The 460V models require 90-degree wire to meet UL regulations

Table 8. Cable and fuse sizes for Honeywell Smart VFD HVAC (MR4 to MR6)

The cable dimensioning is based on the criteria of the Underwriters' Laboratories UL508C:Cables must be PVC-isolated; Max ambient temperature +86°F, max temperature of cable surface +158°F; Use only cables with concentric copper shield; Max number of parallel cables is 9.
When using cables in parallel, **NOTE HOWEVER** that the requirements of both the cross-sectional area and the max number of cables must be observed.
For important information on the requirements of the grounding conductor, see standard Underwriters' Laboratories UL508C.

For the correction factors for each temperature, see the instructions of standard Underwriters' Laboratories UL508C.

4.1.1.2 Cable and fuse sizes, frames MR7 to MR9, North America

The recommended fuse types are gG/gL (IEC 60269-1) or class T (UL & CSA). The fuse voltage rating should be selected according to the supply network. The final selection should be made according to local regulations, cable installation conditions and cable specification. Bigger fuses than what is recommended below shall not be used.

Check that the fuse operating time is less than 0.4 seconds. Operating time depends on used fuse type and impedance of the supply circuit. Consult the factory about faster fuses. Honeywell offers recommendations also for high speed J (UL & CSA), aR (UL recognized, IEC 60269-4) and gS (IEC 60269-4) fuse ranges.

Frame	Type	I_L [A]	Fuse (class T) [A]	Mains, motor and ground cable Cu	Terminal cable size	
					Main terminal	Ground terminal
MR7	C 0500	72,0	100	AWG2	AWG9-AWG2/0	AWG9-AWG2/0
	C 0600	87,0	110	AWG1	AWG9-AWG2/0	AWG9-AWG2/0
	C 0750	105,0	150	AWG1/0	AWG9-AWG2/0	AWG9-AWG2/0
MR8	C 1000	140,0	200	AWG3/0	AWG1-350 kcmil	AWG1-350 kcmil
	C 1250	170,0	225	250 kcmil	AWG1-350 kcmil	AWG1-350 kcmil
	C 1500	205,0	250	350 kcmil	AWG1-350 kcmil	AWG1-350 kcmil
MR9	C 2000	261,0	350	2*250 kcmil	AWG1-350 kcmil	AWG1-350 kcmil
	C 2500	310,0	400	2*350 kcmil	AWG1-350 kcmil	AWG1-350 kcmil

Table 9. Cable and fuse sizes for Honeywell Smart VFD HVAC (MR7 to MR9)

The cable dimensioning is based on the criteria of the Underwriters' Laboratories UL508C:Cables must be PVC-isolated; Max ambient temperature +86°F, max temperature of cable surface +158°F; Use only cables with concentric copper shield; Max number of parallel cables is 9.
When using cables in parallel, **NOTE HOWEVER** that the requirements of both the cross-sectional area and the max number of cables must be observed.
For important information on the requirements of the grounding conductor, see standard Underwriters' Laboratories UL508C.

For the correction factors for each temperature, see the instructions of standard Underwriters' Laboratories UL508C.

4.2 Brake resistor cables

The SmartVFD HVAC is equipped with terminals for an optional external brake resistor. These terminals are marked with R+ and R- (MR4-MR6) or DC+/R+ and R- (MR7 and bigger).

4.3 Control cables

For information on control cables see chapter Control unit cabling.

4.4 Cable installation

- Before starting, check that none of the components of the drive is live. Read carefully the warnings in chapter 1.
- Place the motor cables sufficiently far from other cables
- Avoid placing the motor cables in long parallel lines with other cables.
- If the motor cables run in parallel with other cables note the minimum distances between the motor cables and other cables given in table below.

Distance between cables, [in]	Shielded cable, [ft]
11.8	≤ 164
39.4	≤ 656

- The given distances also apply between the motor cables and signal cables of other systems.
- The maximum lengths of motor cables are 328 ft. (MR4), 492 ft. (MR5 and MR6) and 656 ft. (MR7 to MR9).
- The motor cables should cross other cables at an angle of 90 degrees.
- If cable insulation checks are needed, see chapter Cable and motor insulation checks.

Start the cable installation according to the instructions below:

4.4.1 Frames MR4 to MR7

1	Strip the motor and mains cables as advised below.

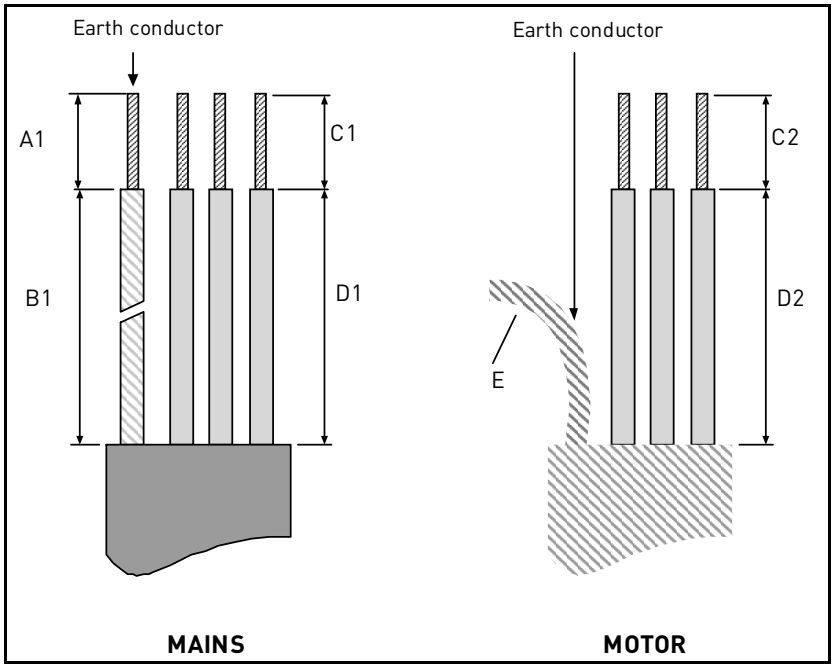


Figure 17. Stripping of cables

Frame	A1	B1	C1	D1	C2	D2	E
MR4	.59	1.38	.39	.79	.28	1.38	Leave as short as possible
MR5	.79	1.57	.39	1.18	.39	1.57	
MR6	.79	3.54	.59	2.36	.59	2.36	
MR7	.79	3.15	.79	3.15	.79	3.15	

Table 10. Cables stripping lengths [in]

2	Open the cover of the drive.

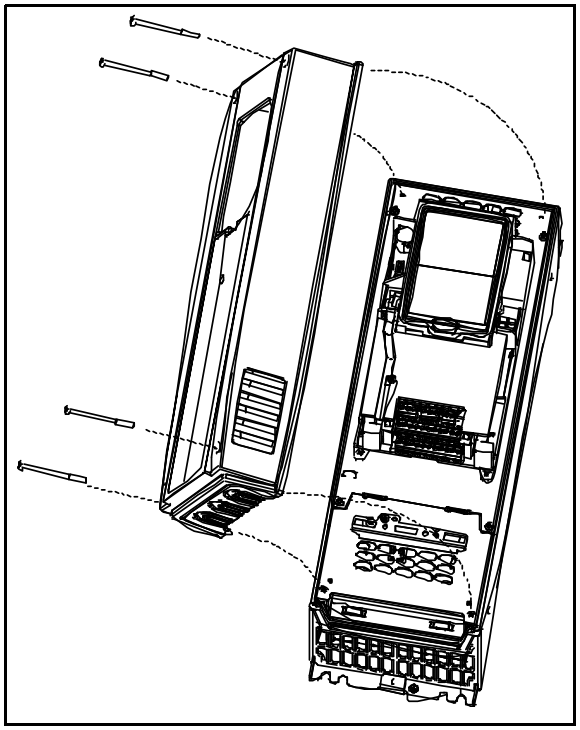


Figure 18.

3	**Remove the screws** of the cable protection plate. Do not open the cover of the power unit!

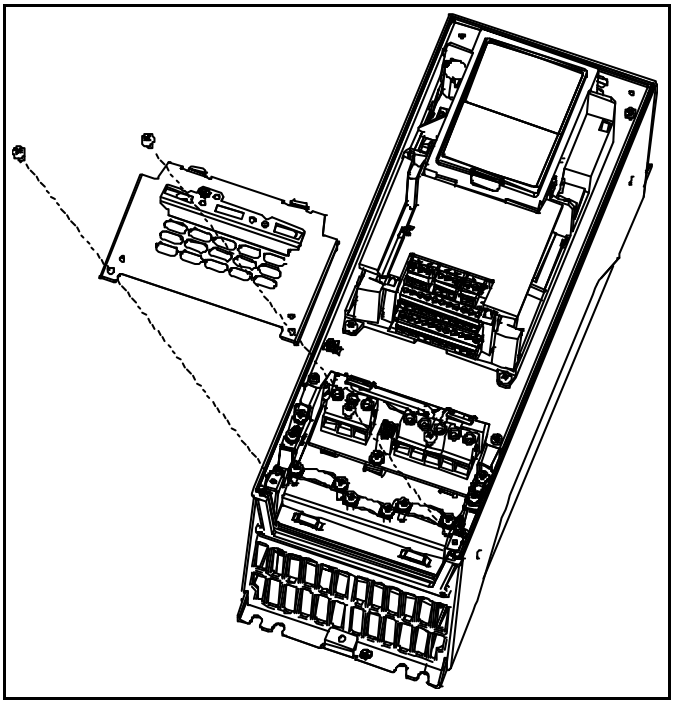


Figure 19.

4	Insert the cable grommets (included in the delivery) in the openings of the cable entry plate (included) as shown in the picture.

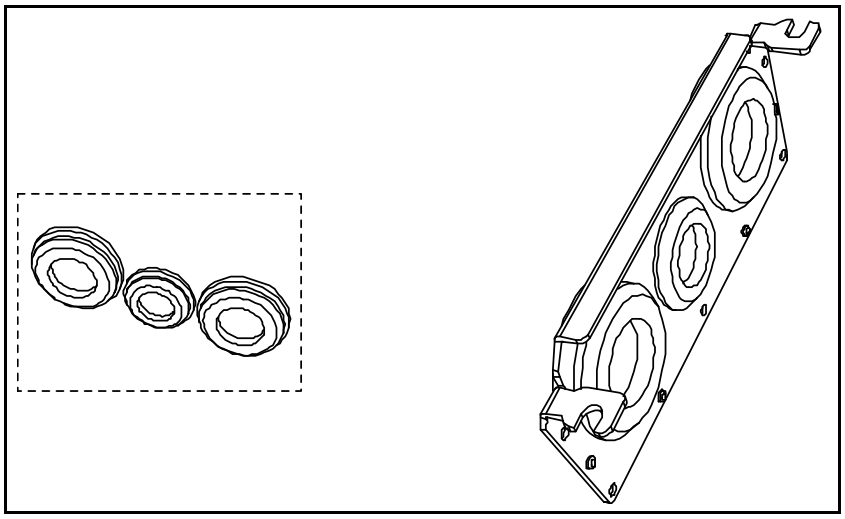


Figure 20.

5	Insert the cables - supply cable, motor cable and optional brake cable - in the openings of the cable entry plate. Then cut the rubber grommets open to slide the cables through. Do not cut the grommet openings wider than what is necessary for the cables you are using. **IMPORTANT NOTE FOR NEMA12 INSTALLATION:** To meet the requirements of the enclosure class NEMA12, the connection between the grommet and the cable must be tight. Therefore, lead the first bit of the cable out of the grommet straight before letting it bend. If this is not possible, the tightness of the connection must be ensured with insulation tape or a cable tie.

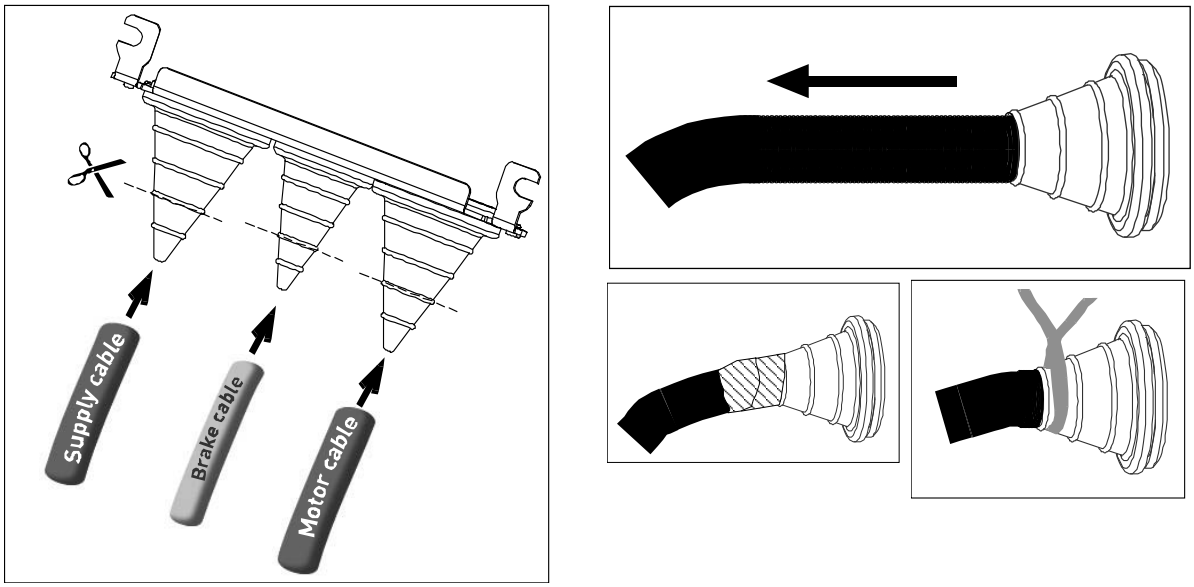


Figure 21.

6	Detach the cable clamps and the grounding clamps (Figure 22) and place the cable entry plate with the cables in the groove on the drive frame (Figure 23).

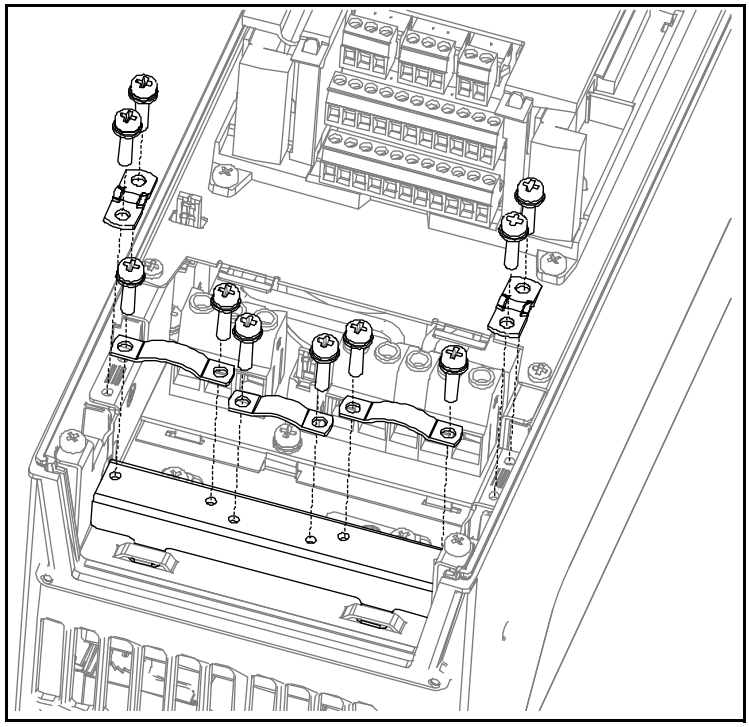


Figure 22.

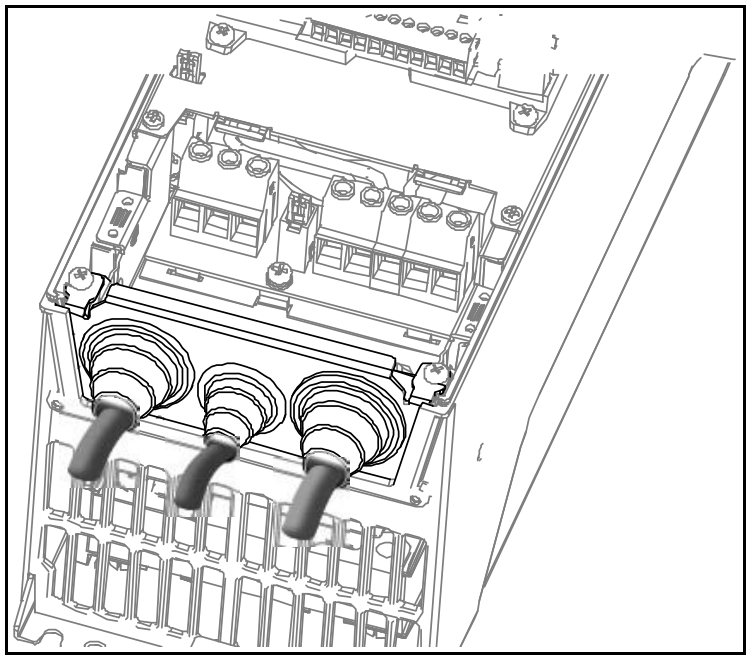


Figure 23.

7	Connect the stripped cables (see Figure 17 and Table 10) as shown in Figure 24. • Expose the shield of all three cables in order to make a 360-degree connection with the cable clamp (1). • Connect the (phase) conductors of the supply, brake and motor cables into their respective terminals (2). • Form the rest of the cable shield of all three cables into “pigtails” and make a grounding connection with a clamp as shown in Figure 24 (3). Make the pigtails **just long enough** to reach and be fixed to the terminal - not longer.

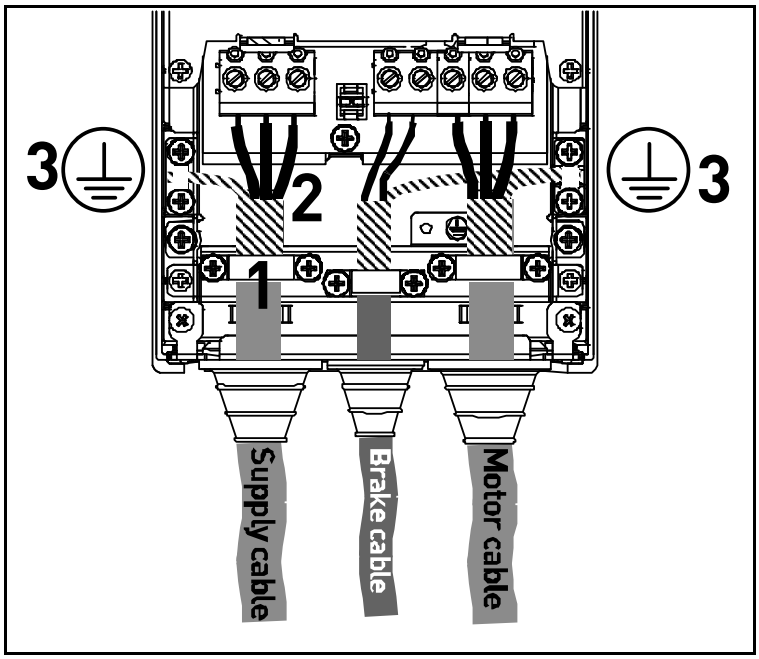


Figure 24.

Tightening torques of cable terminals:

Frame	Type	Tightening torque [Nm]/[lb-in.] Power and motor terminals		Tightening torque [Nm]/[lb-in.] EMC grounding clamps		Tightening torque, [Nm]/[lb-in.] Grounding terminals	
		[Nm]	lb-in.	[Nm]	lb-in.	[Nm]	lb-in.
MR4	C 0015—C 0075	0.5—0.6	4.5—5.3	1.5	13.3	2.0	17.7
MR5	C 0100—C 0200	1.2—1.5	10.6—13.3	1.5	13.3	2.0	17.7
MR6	C 0250—C 0400	10	88.5	1.5	13.3	2.0	17.7
MR7	C 0500—C 0750	8/15*	70.8/132.8*	1.5	13.3	8/15*	70.8/132.8*

*. Cable clamping (Ouneva Pressure Terminal Connector)

Table 11. Tightening torques of terminals

8	Check the connection of the grounding cable to the motor and the drive terminals marked with ⏚. **NOTE**: Two protective conductors are required according to standard EN61800-5-1. See Figure 25 and chapter Grounding and ground fault protection. Use an M5 size screw and tighten it to 2.0 Nm (17.7 lb-in.).

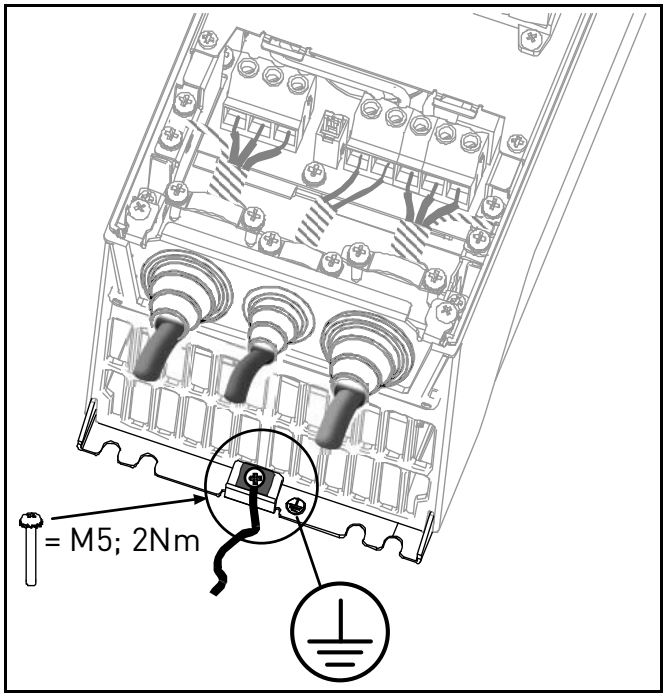


Figure 25. Additional protective grounding connector

9	Re-mount the cable protection plate (Figure 26) and the cover of the drive.

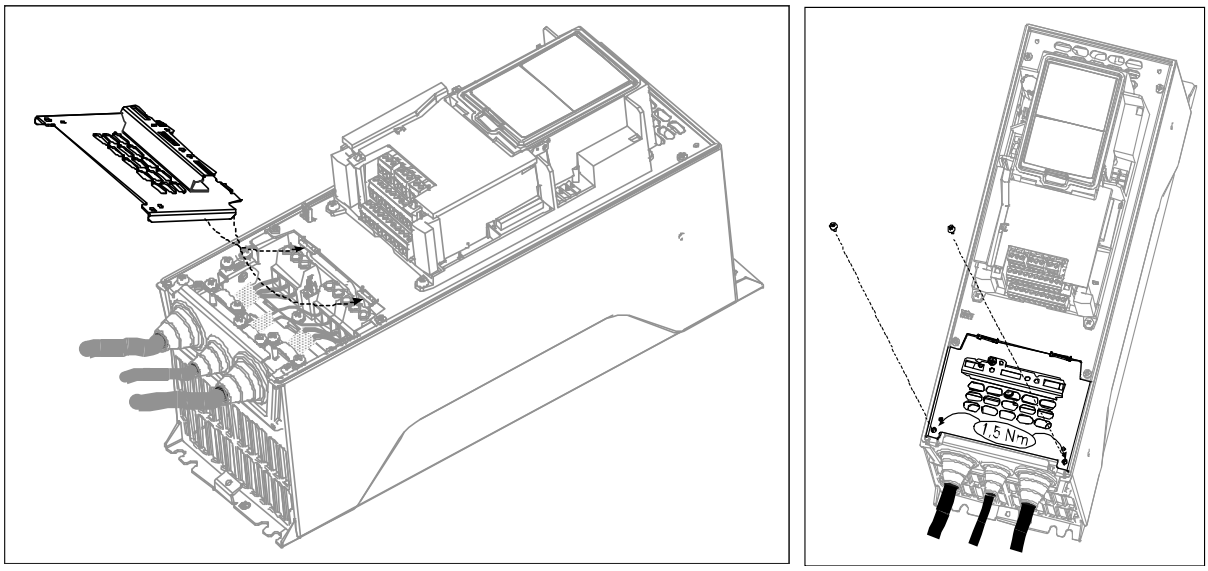


Figure 26. Re-mounting of cover components

4.4.2 Frames MR8 and MR9

1	Strip the motor and mains cables as advised below.

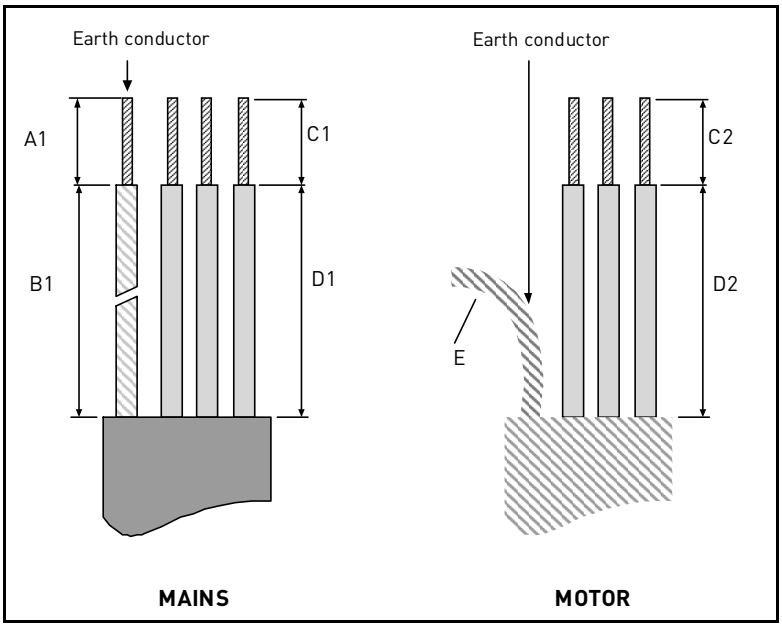


Figure 27. Stripping of cables

Frame	A1	B1	C1	D1	C2	D2	E
MR8	1.57	7.09	.98	11.81	.98	11.81	Leave as short as possible
MR9	1.57	7.09	.98	11.81	.98	11.81	

Table 12. Cables stripping lengths [in]

2	**MR9 only:** Remove the main cover of the AC drive.

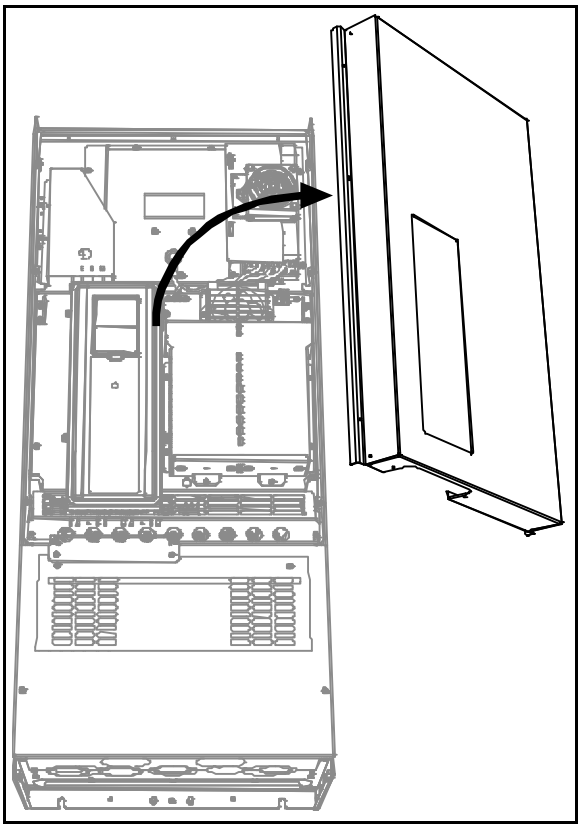


Figure 28.

3	Remove the cable cover (1) and the cable fitting plate (2).

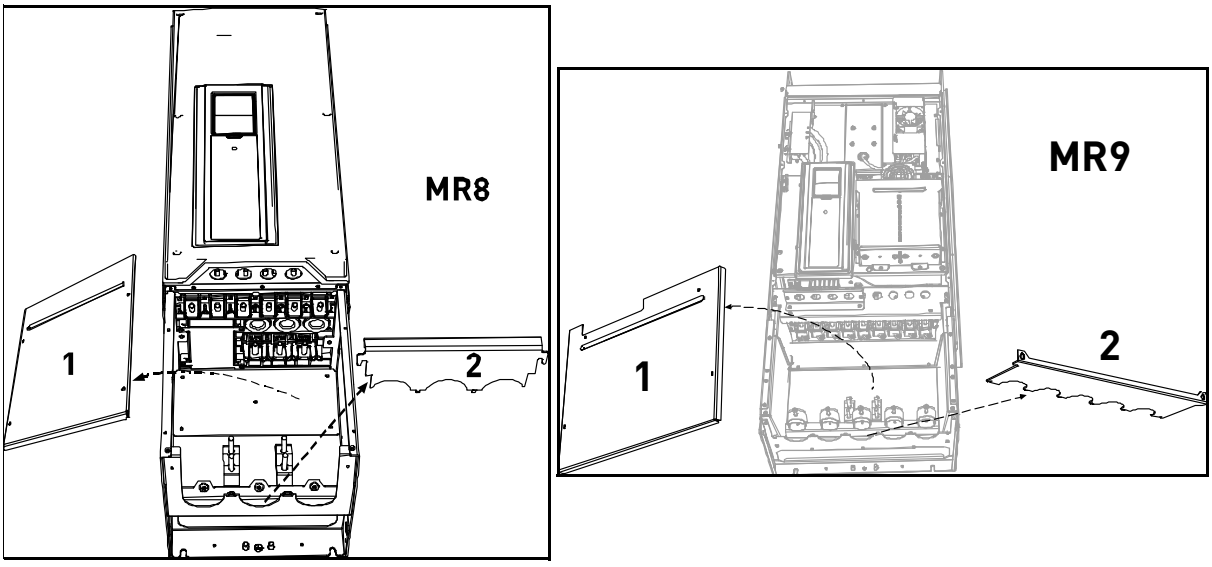


Figure 29.

4	**MR9 only:** Loosen the screws and remove the sealing plate.

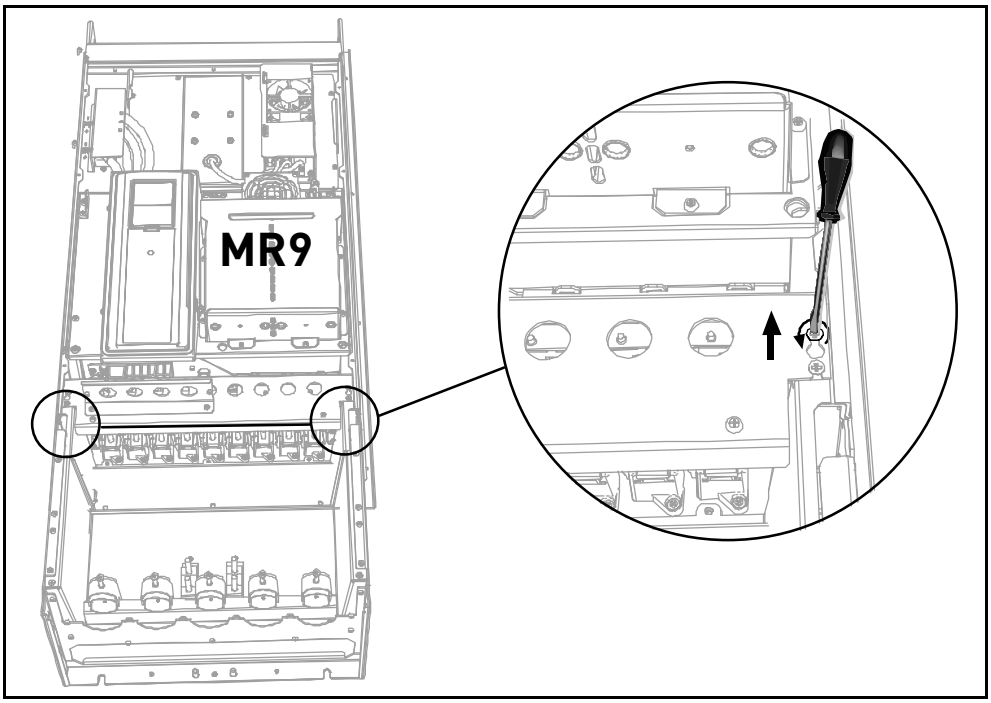


Figure 30.

5	Locate the terminals. **OBSERVE** the exceptional placement of motor cable terminals in MR8!

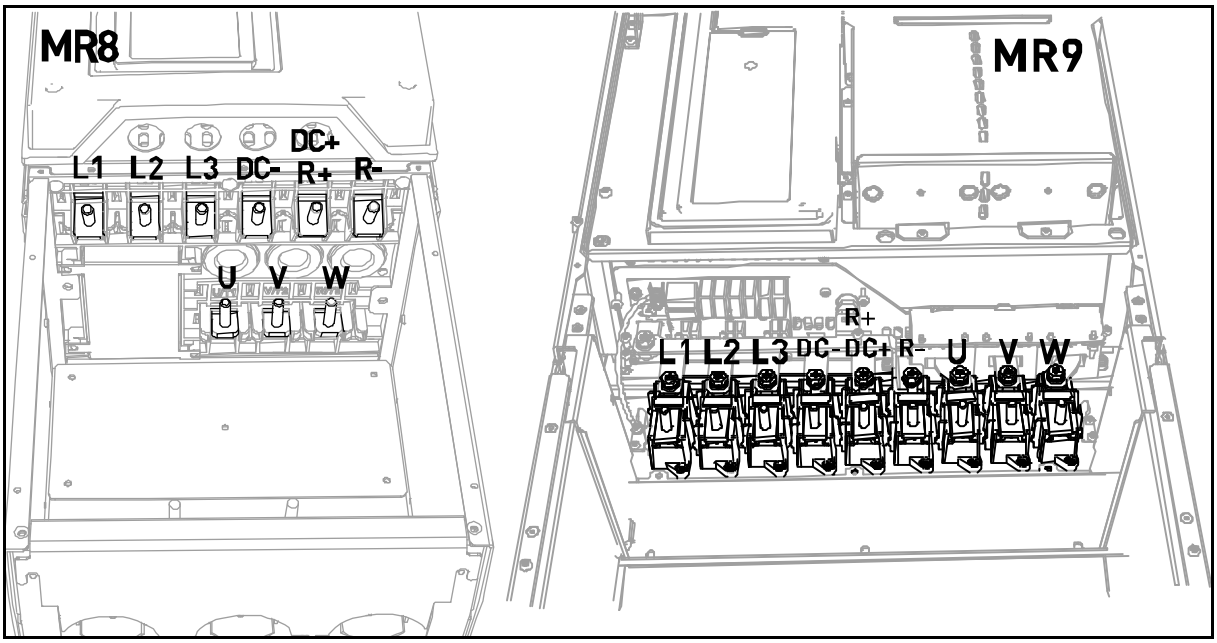


Figure 31.

6	Cut the rubber grommets open to slide the cables through. Should the grommets fold in while inserting the cable, just draw the cable back a bit to straighten the grommets up. Do not cut the grommet openings wider than what is necessary for the cables you are using.

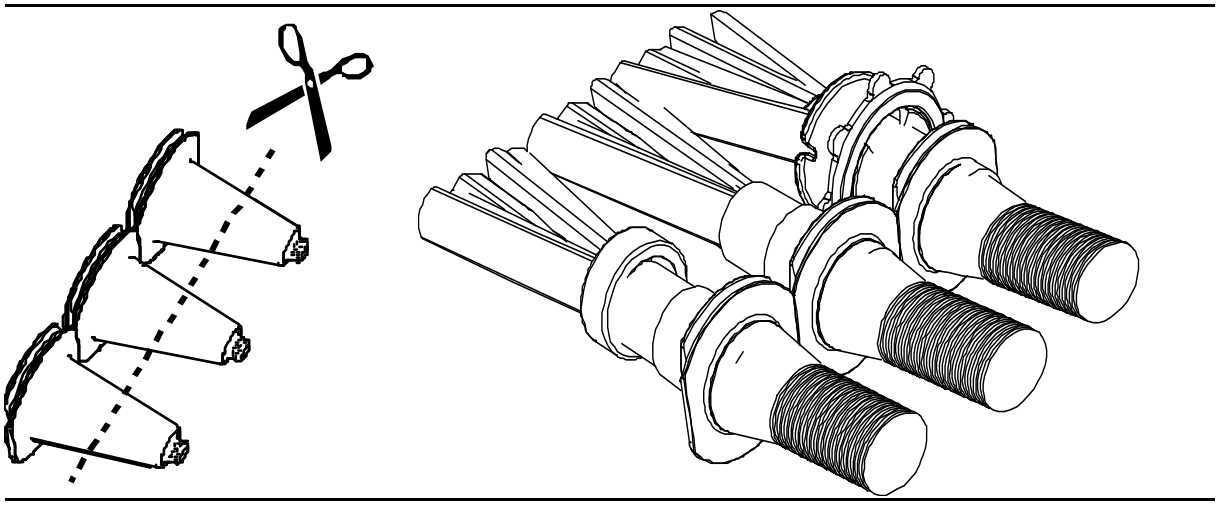


Figure 32.

7	Place the grommet with the cable so that the frame end plate fits in the groove on the grommet, see Figure 33. To meet the requirements of the enclosure class NEMA12, the connection between the grommet and the cable must be tight. Therefore, lead the first bit of the cable out of the grommet **straight** before letting it bend. If this is not possible, the tightness of the connection must be ensured with insulation tape or a cable tie. As an example,see Figure 21.

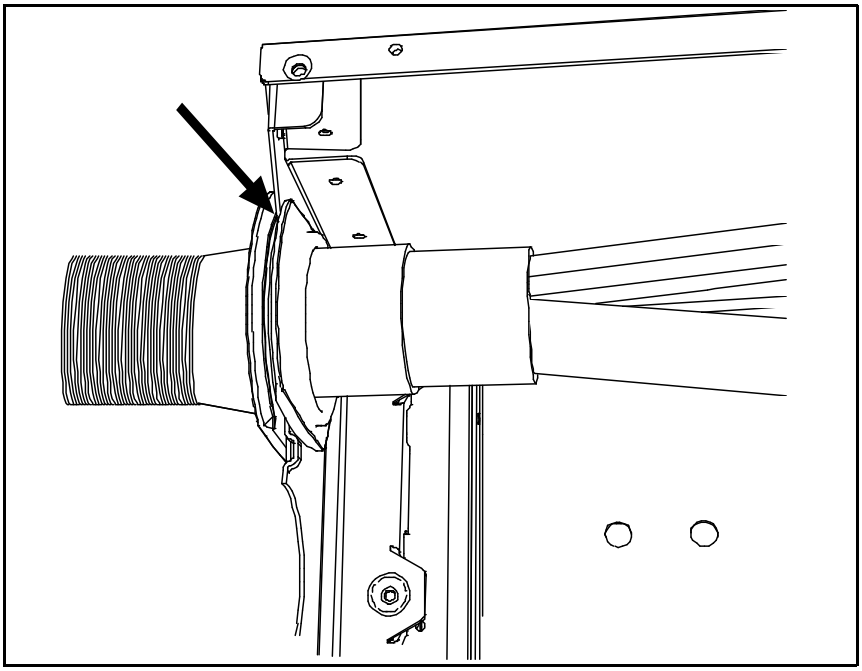


Figure 33.

8	If you use thick cables insert the cable separators in between the terminals in order to avoid contact between the cables.

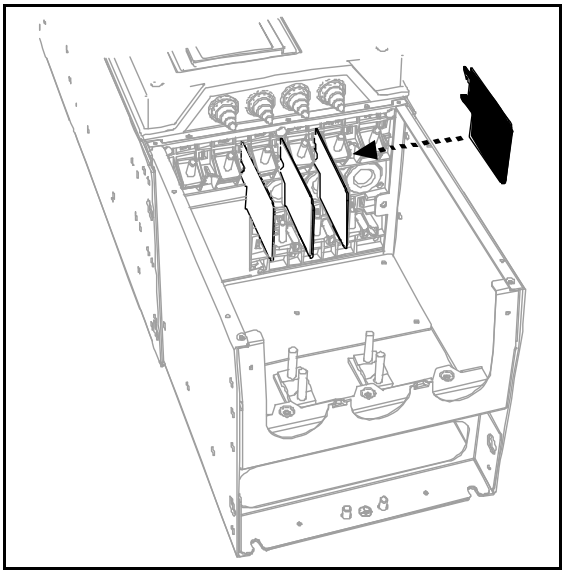


Figure 34.

9	Connect the cables stripped as shown in Figure 27. • Connect the (phase) conductors of the supply, brake and motor cables into their respective terminals (a). • Form the rest of the cable shield of all cables into “pigtails” and make a grounding connection as shown in Figure 35 (b) using the clamp from the *Accessories bag*. • Note also correct position of the ferrite holder (c) AFTER the cable stripping (in MR8 and EMC class C2 only). • Note: If you use several cables on one connector observe the position of cable lugs on top of each other. See Figure 36 below.

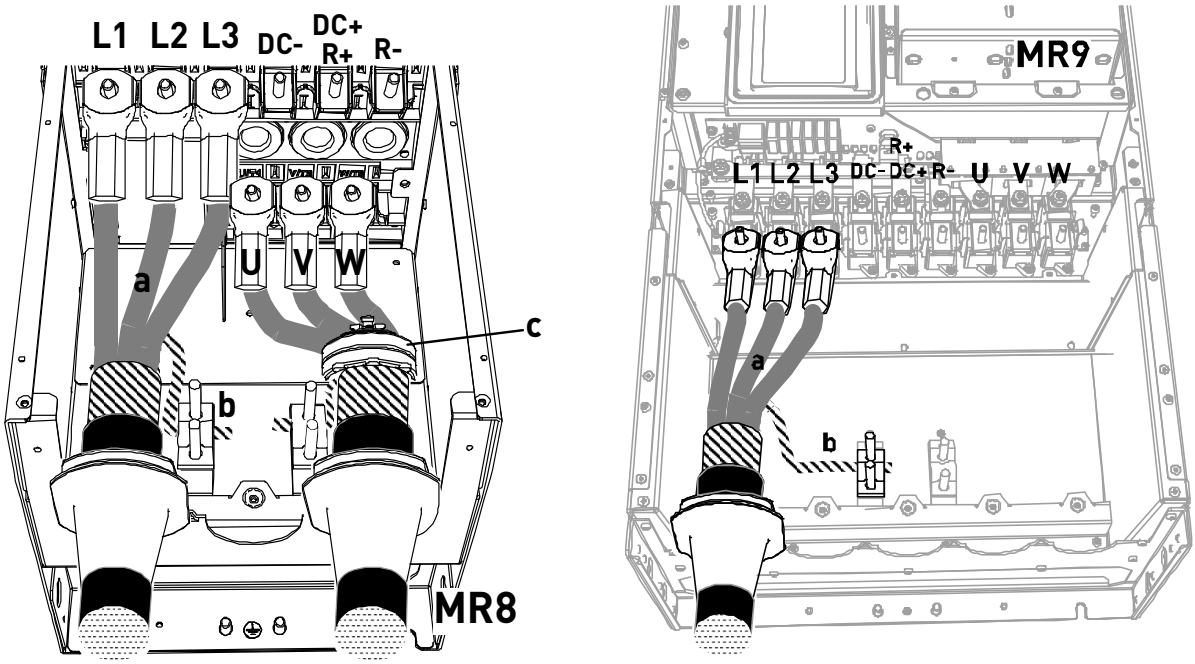


Figure 35.

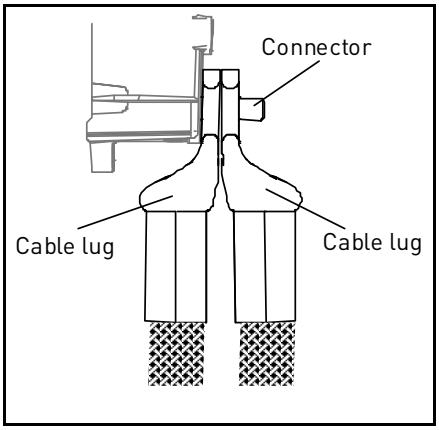


Figure 36. Placing two cable lugs on top of each other

Tightening torques of cable terminals:

Frame	Type	Tightening torque [Nm]/[lb-in.] Power and motor terminals		Tightening torque [Nm]/[lb-in.] EMC grounding clamps		Tightening torque, [Nm]/[lb-in.] Grounding terminals	
		[Nm]	lb-in.	[Nm]	lb-in.	[Nm]	lb-in.
MR8	C 1000—C 1500	20/40*	177/354*	1.5	13.3	20	177
MR9	C 2000—C 2500	20/40*	177/354*	1.5	13.3	20	177

*. Cable clamping (Ouneva Pressure Terminal Connector)

Table 13. Tightening torques of terminals

10	Expose the shield of all three cables in order to make a 360-degree connection with the cable clamp.

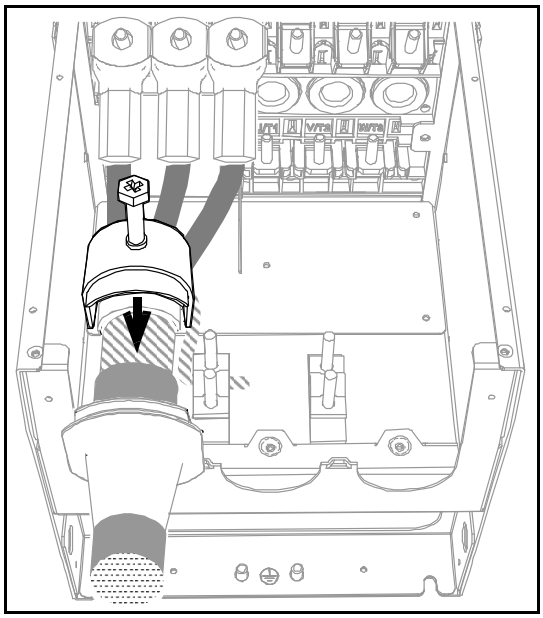


Figure 37.

11	Re-attach first the cable fitting plate and then the cable cover.

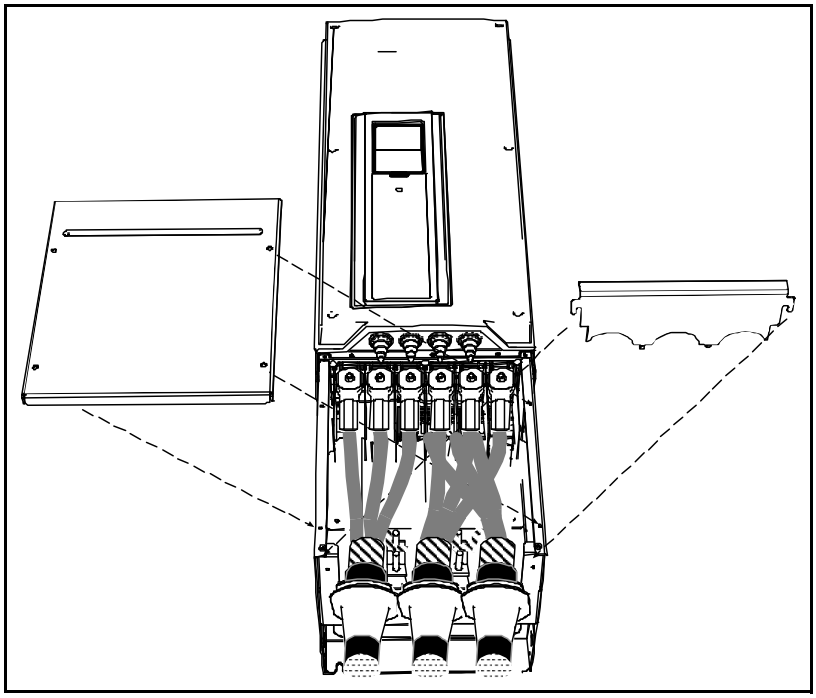


Figure 38.

12	**MR9 only:** Now re-mount the main cover (unless you want to make the control connections first).

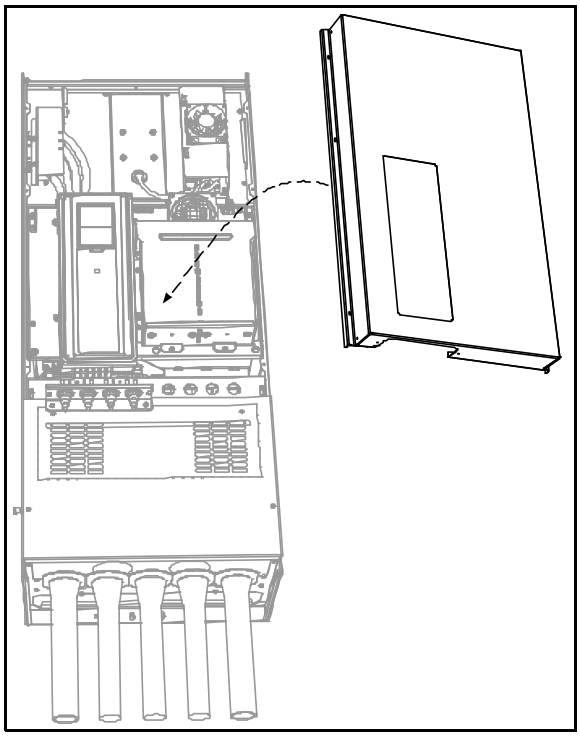


Figure 39.

13	Check the connection of the earth cable to the motor and the AC drive terminals marked with ⏚ . **NOTE**: Two protective conductors are required according to standard EN61800-5-1. See chapter Grounding and ground fault protection. Connect the protective conductor using a cable shoe and an M8 screw (included in the *Accessories bag*) on **either** of the screw connectors as advised in Figure 40.

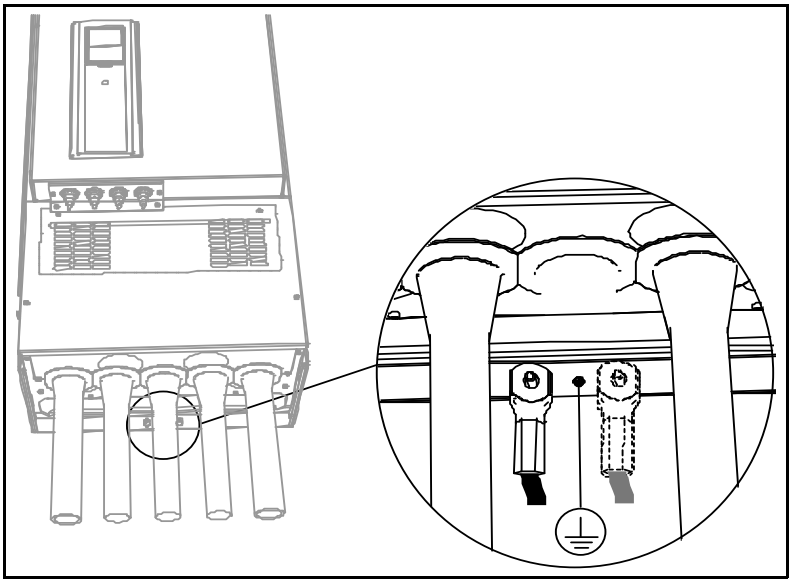


Figure 40.

4.4.3 Cable and motor insulation checks

1. Motor cable insulation checks
   Disconnect the motor cable from terminals U, V and W of the drive and from the motor. Measure the insulation resistance of the motor cable between each phase conductor as well as between each phase conductor and the protective ground conductor. The insulation resistance must be >1MΩ at ambient temperature of 68°F.
2. Mains cable insulation checks
   Disconnect the mains cable from terminals L1, L2 and L3 of the drive and from the mains. Measure the insulation resistance of the mains cable between each phase conductor as well as between each phase conductor and the protective ground conductor. The insulation resistance must be >1MΩ at ambient temperature of 68°F.
3. Motor insulation checks
   Disconnect the motor cable from the motor and open the bridging connections in the motor connection box. Measure the insulation resistance of each motor winding. The measurement voltage must equal at least the motor nominal voltage but not exceed 1000 V. The insulation resistance must be >1MΩ at ambient temperature of 68°F.

5. COMMISSIONING

Before commissioning, note the following directions and warnings:

	Internal components and circuit boards of the drive (except for the galvanically isolated I/O terminals) are live when it is connected to mains potential. **Coming into contact with this voltage is extremely dangerous and may cause death or severe injury.**
	The motor terminals **U**, **V**, **W** and the brake resistor terminals **B-/B+ are live** when the drive is connected to mains, **even if the motor is not running**.
	The control I/O-terminals are isolated from the mains potential. However, the **relay outputs and other I/O-terminals may have a dangerous control voltage** present even when the drive is disconnected from mains.
	Do not make any connections to or from the drive when it is connected to the mains.
	After disconnecting the drive from the mains, **wait** until the fan stops and the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait 5 more minutes before doing any work on the connections of the drive. Do not open the cover before this time has expired. After expiration of this time, use a measuring equipment to absolutely ensure that no voltage is present. **Always ensure abscence of voltage before electrical work!**
	Before connecting the frequency converter to mains make sure that the front and cable covers of the drive are closed.

5.1 Commissioning of the SmartVFD HVAC

1	Read carefully the safety instructions in Chapter 1 and above and follow them.
2	After the installation, make sure that: • both the drive and the motor are grounded. • the mains and motor cables comply with the requirements given in chapter 4.1.1. • the control cables are located as far as possible from the power cables, see chapter 4.4. • the shields of the shielded cables are connected to protective ground marked with ⏚. • check the tightening torques of all terminals • the wires do not touch the electrical components of the drive. • the common inputs of digital input groups are connected to +24V or ground of the I/O terminal or the external supply.
3	Check the quality and quantity of cooling air (chapter 3.2 and Table 6).
4	Check the inside of the drive for condensation.
5	**Check that all Start/Stop switches connected to the I/O terminals are in Stop-position.**
6	Before connecting the AC drive to mains: • check mounting and condition of all fuses and other protective devices
7	Run the Startup Wizard (see the Application Manual).

5.2 Changing EMC protection class

If your supply network is an IT (impedance-grounded) system but your AC drive is EMC-protected according to class C2 you need to modify the EMC protection of the AC drive to EMC-level T. This is done by removing the built-in EMC jumpers with a simple procedure described below:

⚠	Warning! Do not perform any modifications on the drive when it is connected to mains.

5.2.1 Frames MR4 to MR7

1	Remove the main cover (frames MR4 to MR7) and the cable cover (frame MR7) of the AC drive (see pages 25 and 26) and locate the jumpers connecting the built-in RFI-filters to ground. See Figure 41.

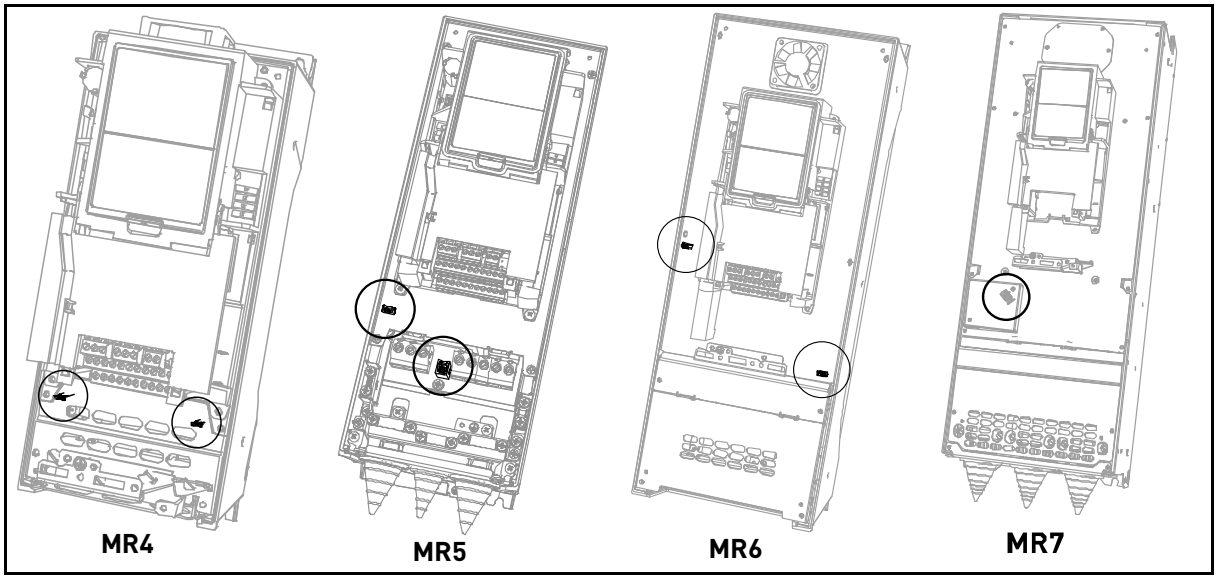


Figure 41. Locations of the EMC-jumpers in frames MR4 to MR7

2	Disconnect the RFI-filters from ground by **removing** the EMC-jumpers using long-nose pliers or similar. See Figure 42.

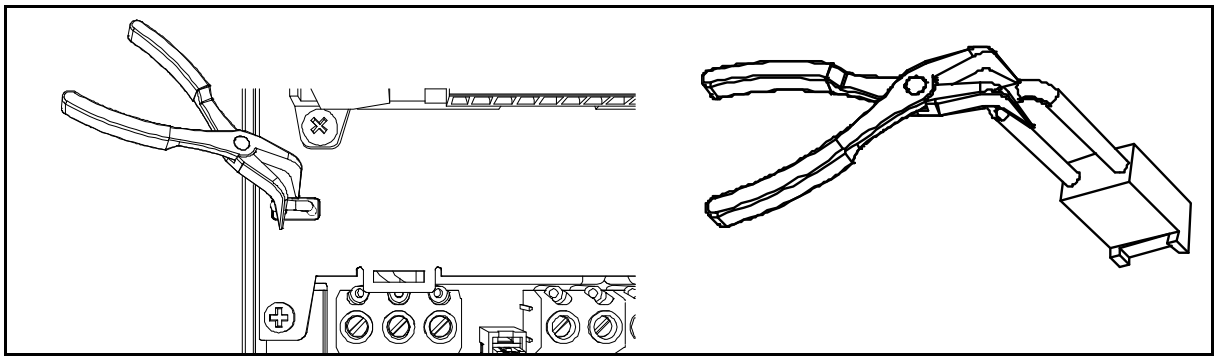


Figure 42. Removing the jumper, MR5 as example

3	Additionally **for MR7**, locate the DC grounding busbar between connectors R- and U and detach the busbar from the frame by undoing the M4 screw.

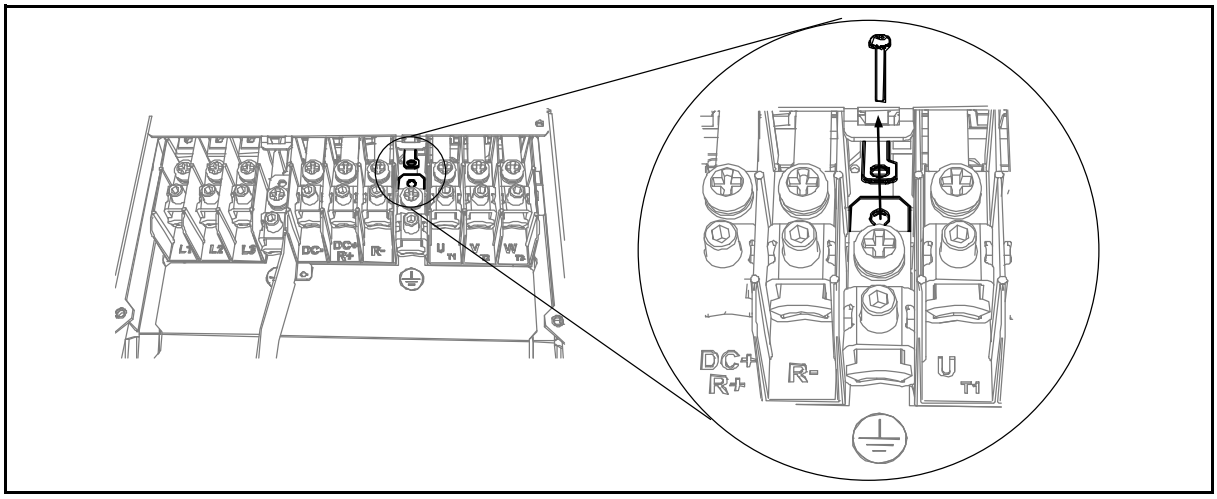


Figure 43. MR7: Detaching the DC grounding busbar from frame

5.2.2 Frame MR8

Follow the procedure described below to modify the EMC protection of the AC drive of frame MR8 to EMC-level **T**.

1	Remove the main cover of the AC drive and locate the jumper. **Push down** the grounding arm. See Figure 44.

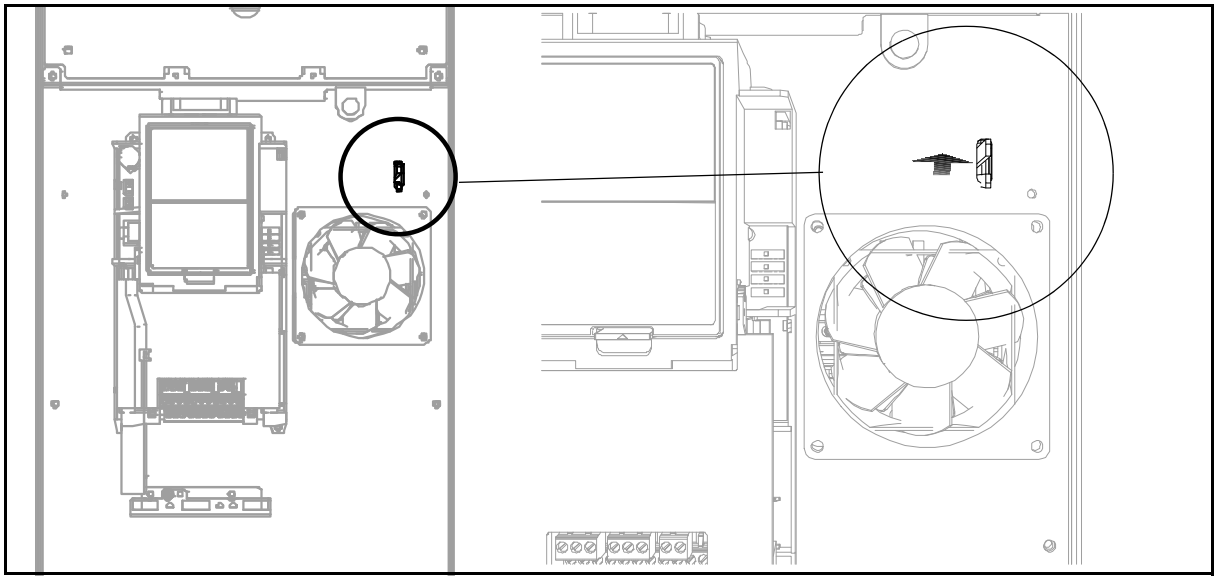


Figure 44.

2	Locate the EMC jumper under the cover and **remove it** using long-nose pliers or similar.

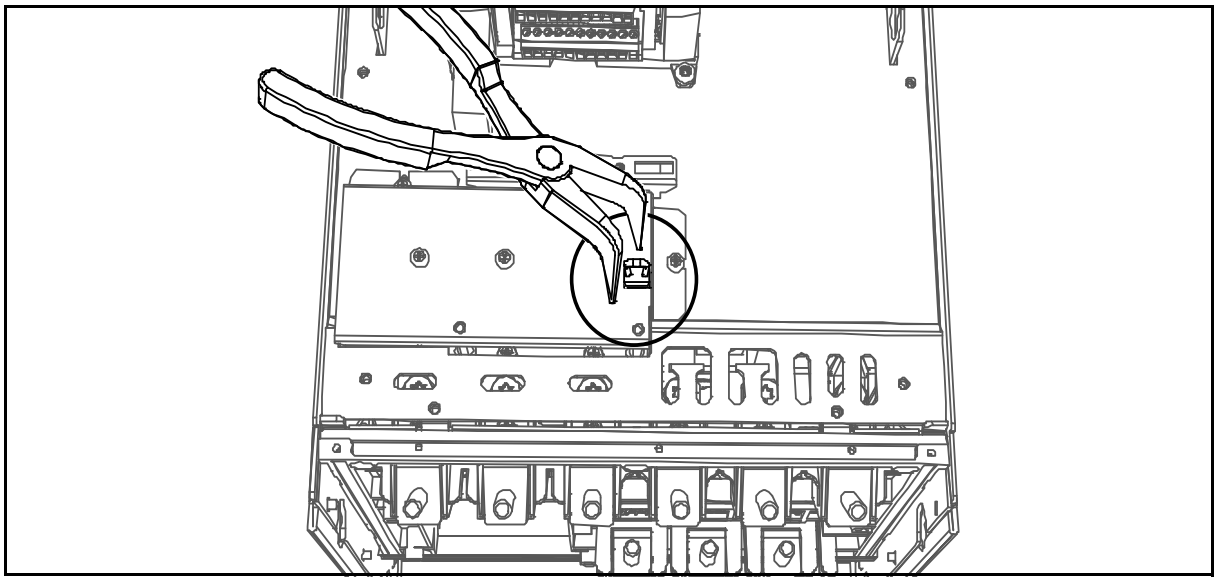


Figure 45.

5.2.3 Frame MR9

Follow the procedure described above to modify the EMC protection of the AC drive of frame MR9 to EMC-level **T**.

1	Find the *Molex* connector in the accessories bag. Remove the main cover of the AC drive and locate the place for the connector next to the fan. Push the Molex connector in its place. See Figure 46.

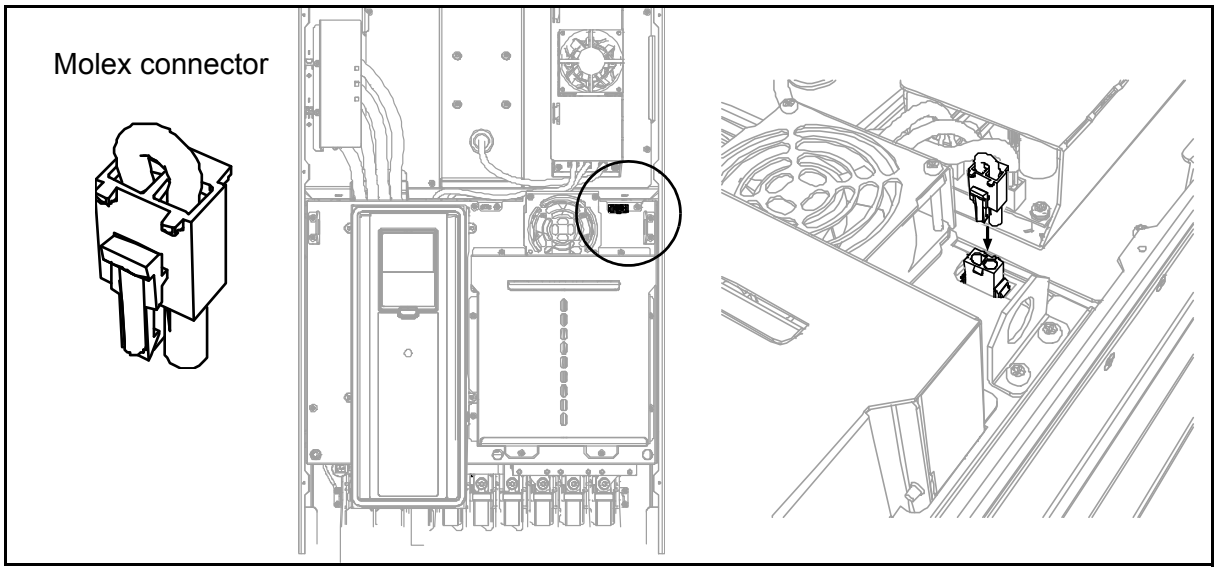


Figure 46.

2	Further remove the extension box cover (1), the touch shield (2) the I/O plate (4) with I/O grommet plate (3). Locate the EMC jumper on the EMC board (see magnification below) and remove it.

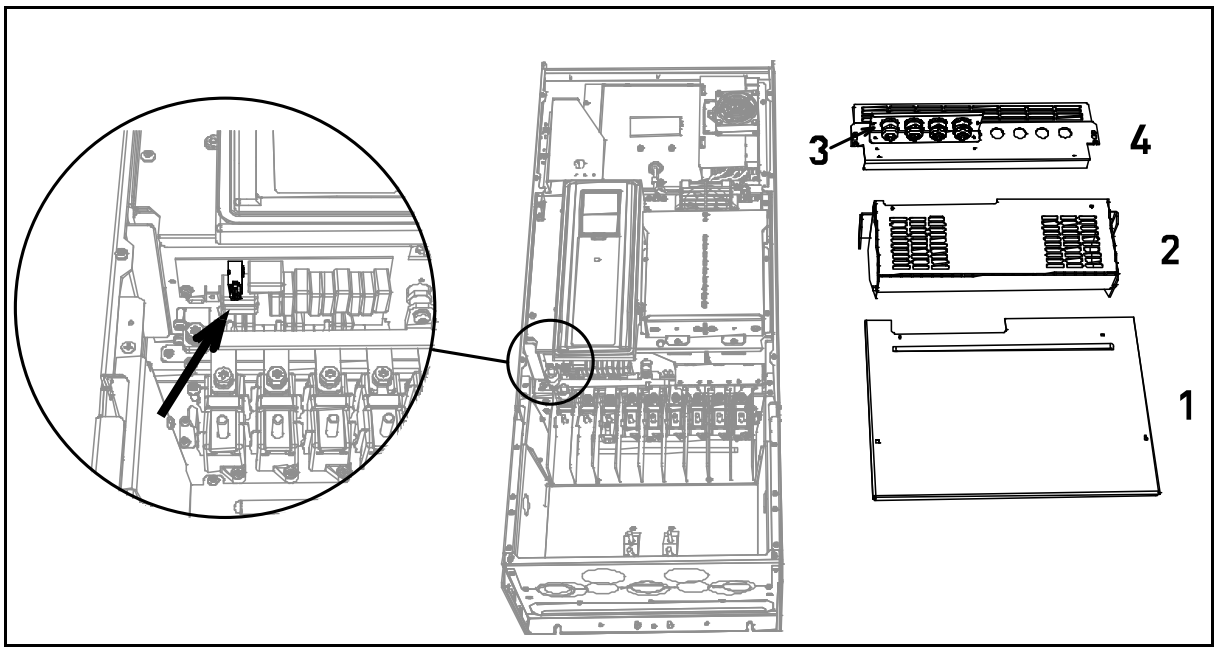
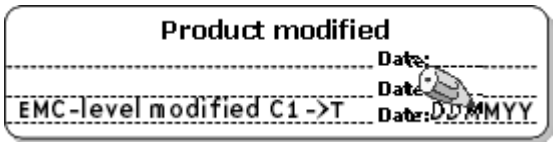
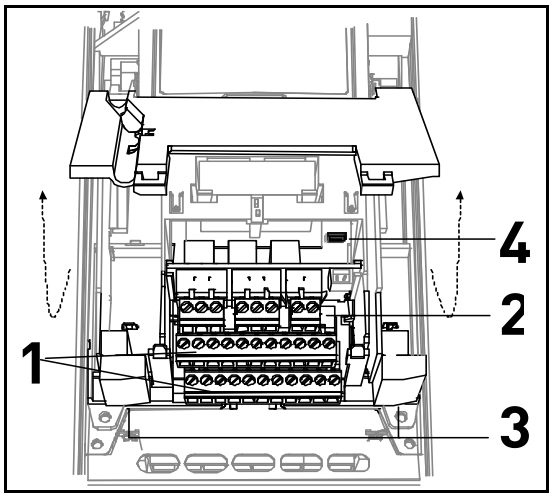


Figure 47.

	CAUTION! Before connecting the AC drive to mains make sure that the EMC protection class settings of the drive are appropriately made.
	NOTE! After having performed the change write *'EMC level modified'* on the sticker included with the drive delivery (see below) and note the date. Unless already done, attach the sticker close to the name plate of the drive. 

6. CONTROL UNIT

The control unit of the drive consists of the control board and additional boards (option boards) connected to the slot connectors of the control board.



Locations of essential control unit components:

1 = Control terminals of the control board

2 = Terminals of relay board; **NOTE:** There are two different compilations of relay boards available. See section 6.1.

3 = Optional boards

4 = Disconnecting jumper for digital inputs, see chapter 6.1.2.2

Figure 48. Location of control unit components

When delivered from the factory, the control unit of the drive contains the standard controlling interface - the control terminals of the control board and the relay board - unless otherwise specifically ordered. On the next pages you will find the arrangement of the control I/O and the relay terminals, the general wiring diagram and the control signal descriptions.

The control board can be powered externally (+24VDC, ±10%) by connecting the external power source to terminal #30, see page 52. This voltage is sufficient for parameter setting and for keeping the control unit active. Note however that the measurements of the main circuit (e.g. DC-link voltage, unit temperature) are not available when the mains is not connected.

6.1 Control unit cabling

The basic control unit connections are presented in Figure 49 below. The control board is equipped with 22 fixed control I/O terminals and the relay board with 8 or 9. The relay board is available in two different configurations (see Table 16 and 17). All signal descriptions are given in Tables 15 to 17.

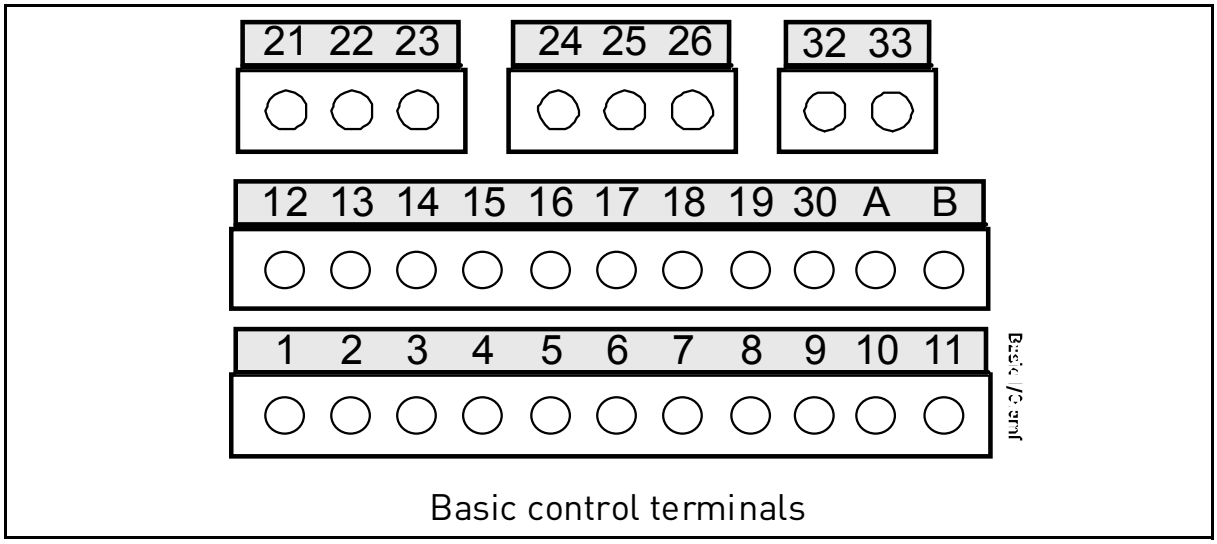


Figure 49.

6.1.1 Control cable sizing

The control cables shall be at least 0.5 mm² screened multicore cables, see Table 7. The maximum terminal wire size is 2.5 mm² for the relay and other terminals.

Find the tightening torques of the control and relay board terminals in Table 14 below.

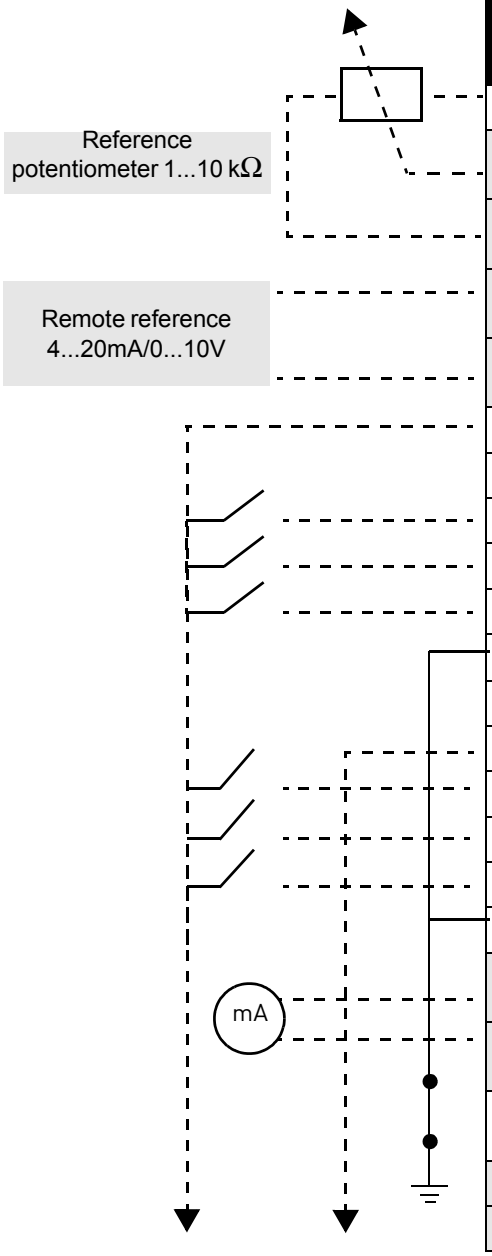
Terminal screw	Tightening torque	
	Nm	lb-in.
All I/O and relay terminals (screw M3)	0.5	4.5

Table 14. Control cable tightening torques

6.1.2 Control terminals and DIP switches

The terminals of the *Basic I/O board* and the *Relay boards* are described below. For more information on the connections, see chapter 7.2.1.

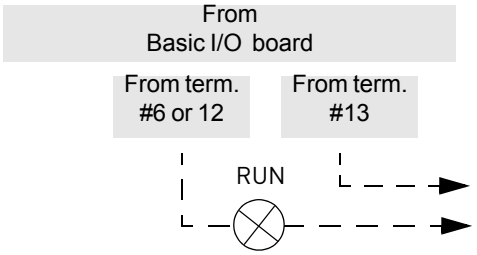
The terminals shown on shadowed background are assigned for signals with optional functions selectable with DIP switches. See more information in chapter 6.1.2.1 on page 52.



Basic I/O board		
Terminal		Signal
1	+10 Vref	Reference output
2	AI1+	Analogue input, voltage or current
3	AI1-	Analogue input common (current)
4	AI2+	Analogue input, voltage or current
5	AI2-	Analogue input common (current)
6	24Vout	24V aux. voltage
7	GND	I/O ground
8	DI1	Digital input 1
9	DI2	Digital input 2
10	DI3	Digital input 3
11	CM	Common for DI1-DI6*
12	24Vout	24V aux. voltage
13	GND	I/O ground
14	DI4	Digital input 4
15	DI5	Digital input 5
16	DI6	Digital input 6
17	CM	Common for DI1-DI6*
18	AO1+	Analogue signal (+output)
19	AO-/GND	Analogue output common
30	+24 VDCin	24VDC auxiliary input voltage
A	RS485	Negative
B	RS485	Positive

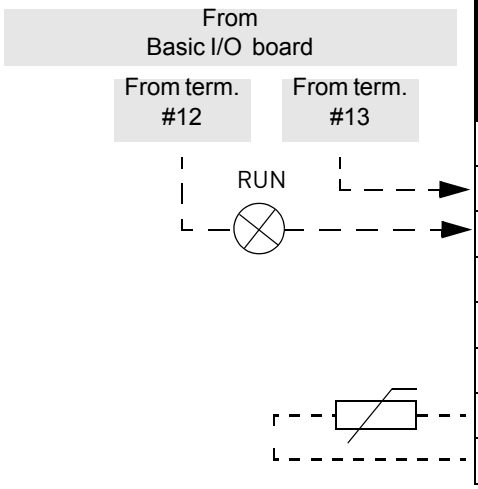
*. Digital inputs can be disconnected from ground, see chapter 6.1.2.2.

Table 15. Control I/O terminal signals on basic I/O board and connection example



Relay board 1		
Terminal		**Signal**
21	RO1/1 NC	Relay output 1
22	RO1/2 CM	
23	RO1/3 NO	
24	RO2/1 NC	Relay output 2
25	RO2/2 CM	
26	RO2/3 NO	
32	RO3/1 CM	Relay output 3
33	RO3/2 NO	

Table 16. Control I/O terminal signals on relay board 1 and connection example



Relay board 2		
Terminal		**Signal**
21	RO1/1	Relay output 1
22	RO1/2	
23	RO1/3	
24	RO2/1	Relay output 2
25	RO2/2	
26	RO2/3	
28	TI1+	Thermistor input
29	TI1-	

Table 17. Control I/O terminal signals on relay board 2 and connection example

6.1.2.1 Selection of terminal functions with dip switches

The shadowed terminals in Table 15 allow for three functional selections each with the so-called *dip switches*. The switches have three positions, left, middle and right. The middle position is for *Test mode*. See figure to locate the switches and make appropriate selections for your requirements.

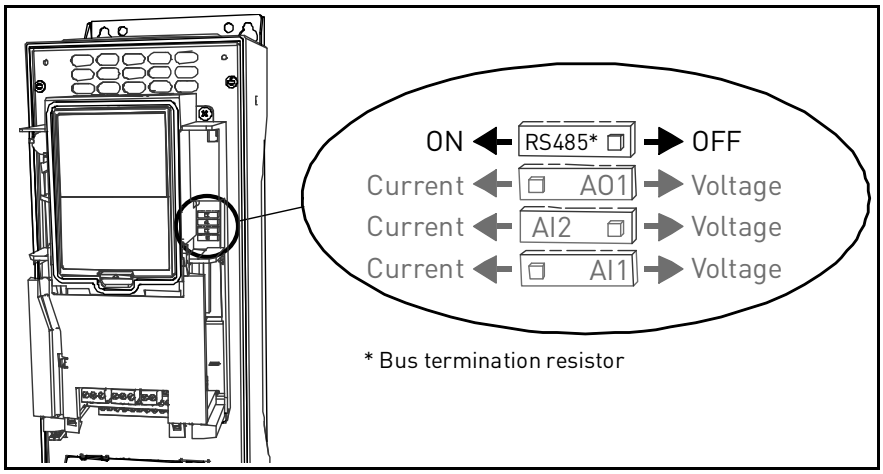


Figure 50. Dip switches

6.1.2.2 Disconnecting digital inputs from ground

The digital inputs (terminals 8-10 and 14-16) on the basic I/O board can be disconnected from ground by removing a jumper on the control board. See Figure 51. Lift the plastic lid to expose the jumper and apply long-nose pliers or similar to remove it.

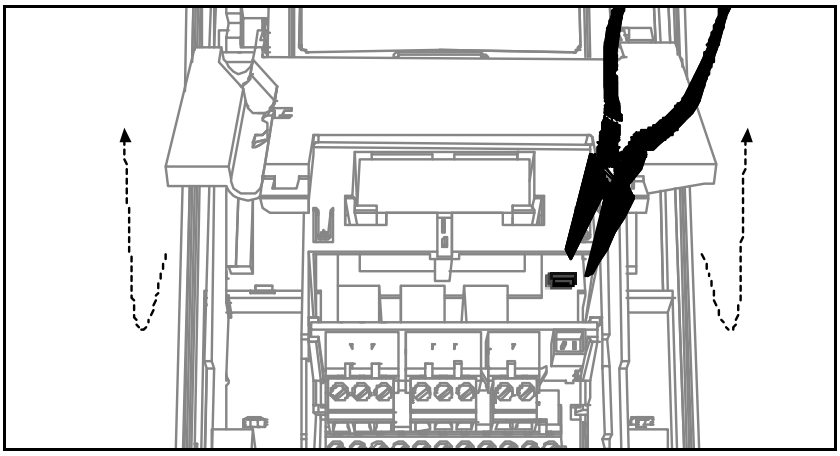


Figure 51. Remove this jumper to disconnect the digital inputs from ground.

6.2 Fieldbus connection

The drive can be connected to fieldbus either through RS485 or Ethernet. The connection for RS485 is on the basic I/O board (terminals A and B) and the connection for Ethernet is under the drive cover, left to the control keypad. See Figure 52.

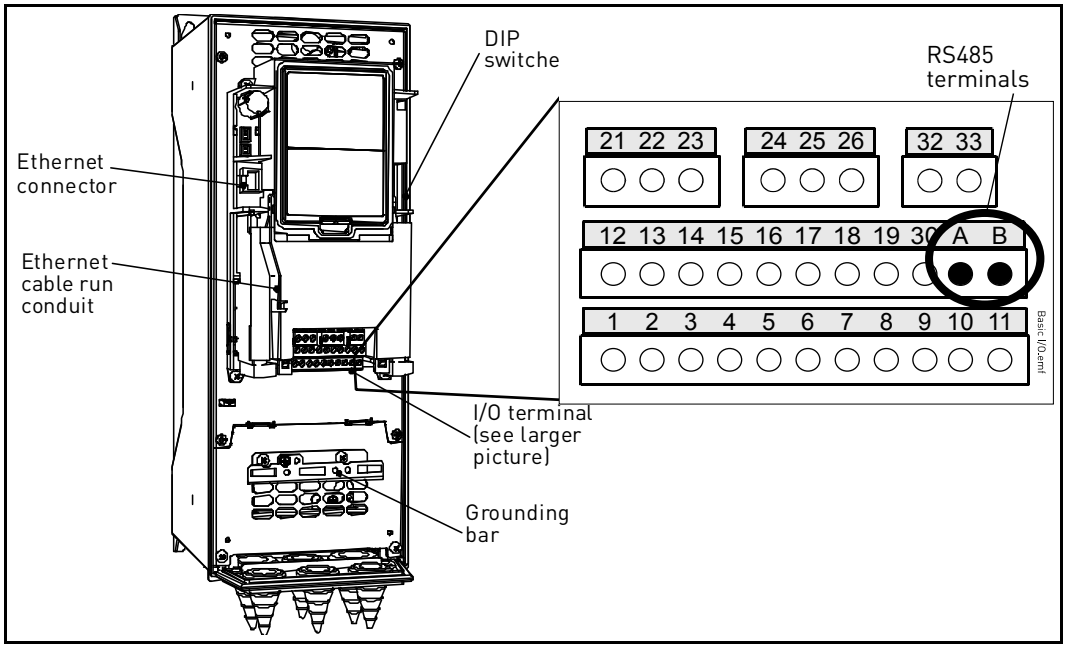


Figure 52.

6.2.1 Prepare for use through ethernet

1	Connect the Ethernet cable (see specification on page 55) to its terminal and run the cable through the conduit as shown in Figure 53.

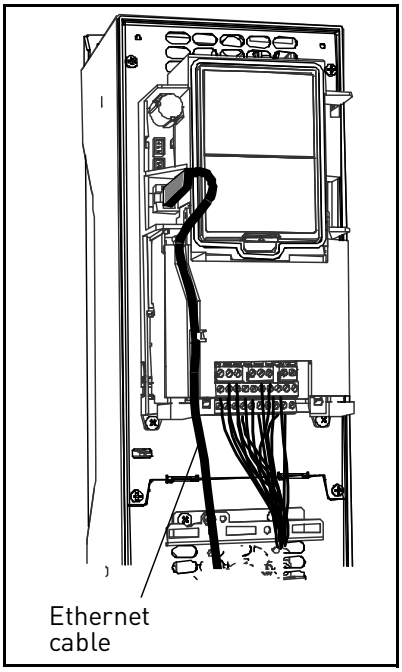


Figure 53.

2	Cut free the opening on the drive cover for the Ethernet cable (protection class IP21).

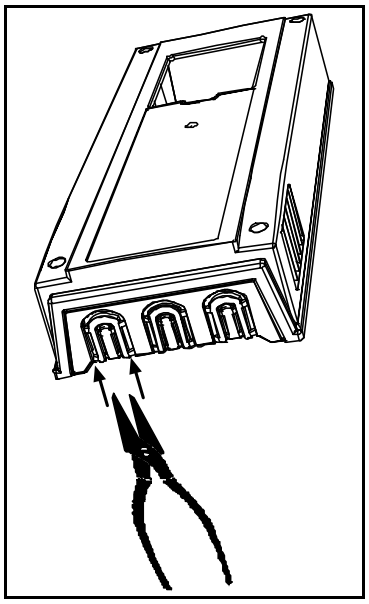


Figure 54.

3	Remount the drive cover. **NOTE:** When planning the cable runs, remember to keep the distance between the Ethernet cable and the motor cable at a **minimum of 12 inch**.

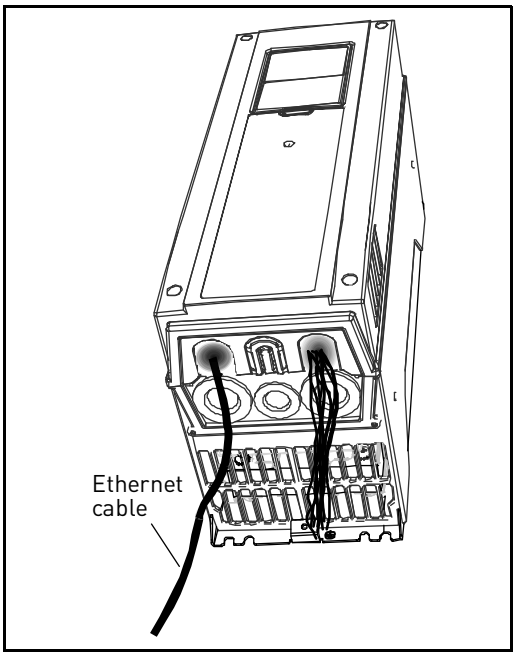


Figure 55.

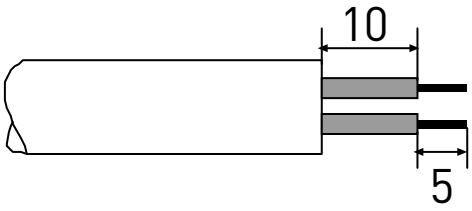
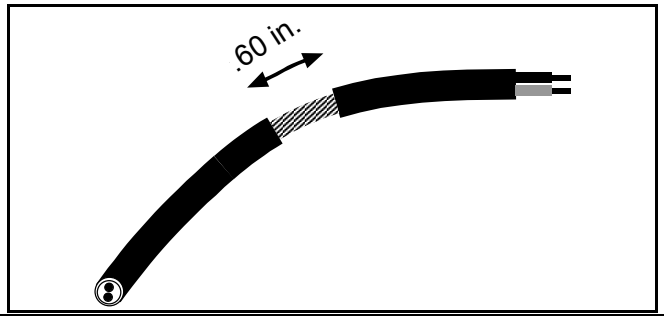
For more detailed information, see the user's manual of the fieldbus you are using.

6.2.1.1 Ethernet cable data

Connector	Shielded RJ45 connector
Cable type	CAT5e STP
Cable length	Max .330 ft.

Table 18. Ethernet cable data

6.2.2 Prepare for use through MS/TP

1	Strip about .60 in. of the RS485 cable (see specification on page 58) and cut off the grey cable shield. Remember to do this for both bus cables (except for the last device). Leave no more than .40 in. of the cable outside the terminal block and strip the cables at about .20 in to fit in the terminals. See picture below.  Also strip the cable now at such a distance from the terminal that you can fix it to the frame with the grounding clamp. Strip the cable at a maximum length of .60 in. **Do not strip the aluminum cable shield!** 

2	Then connect the cable to its appropriate terminals on Honeywell Smart VFD HVAC AC drive standard terminal block, terminals **A and B** (A = negative, B = positive). See Figure 56.

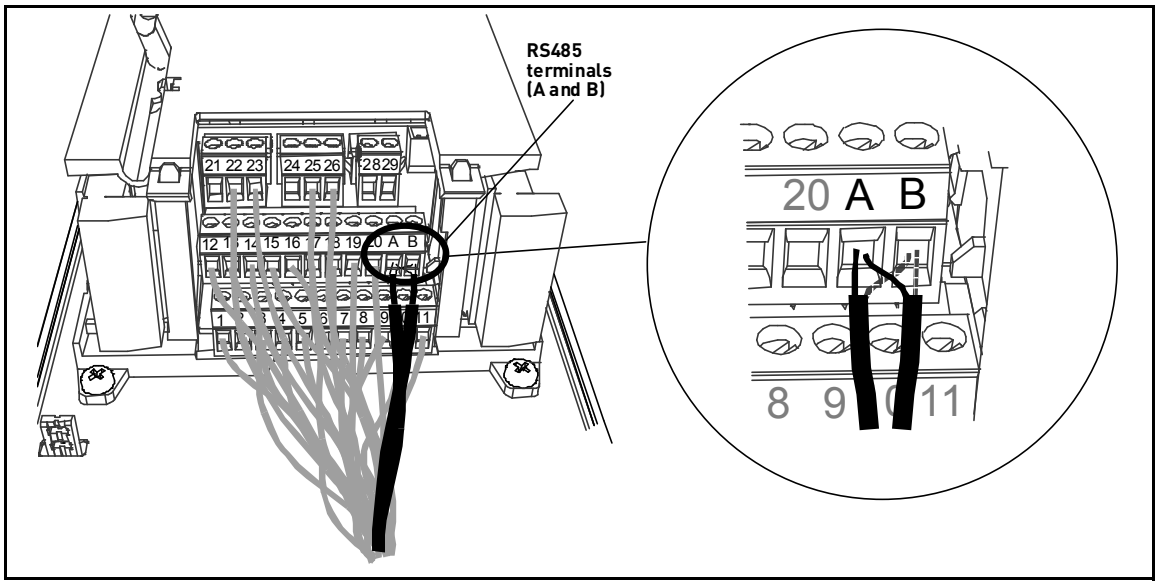
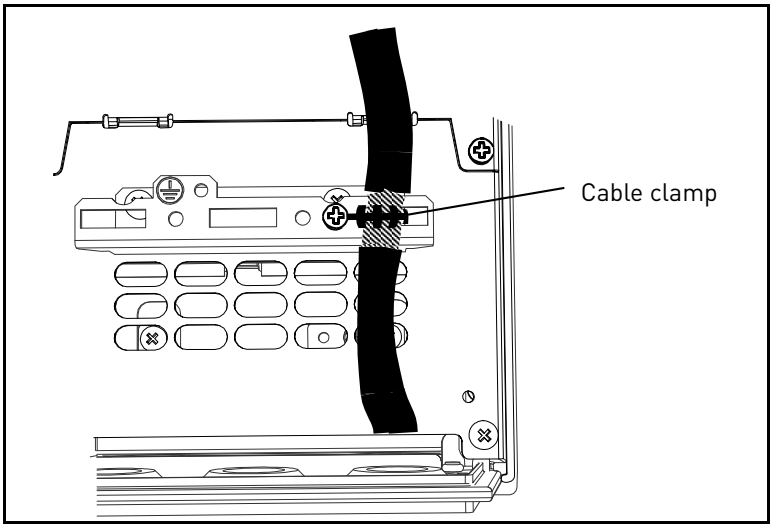
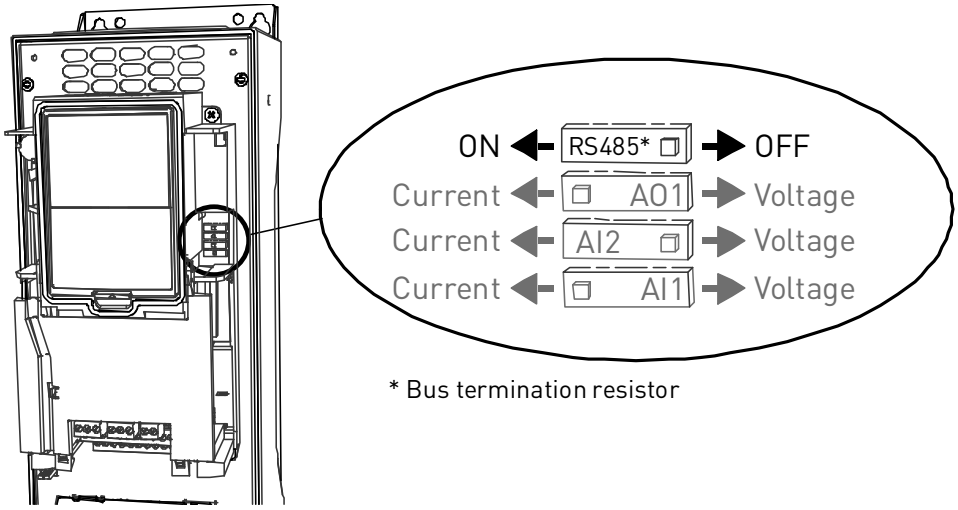
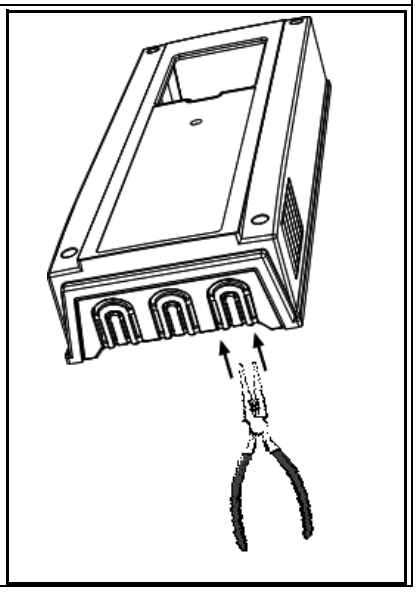
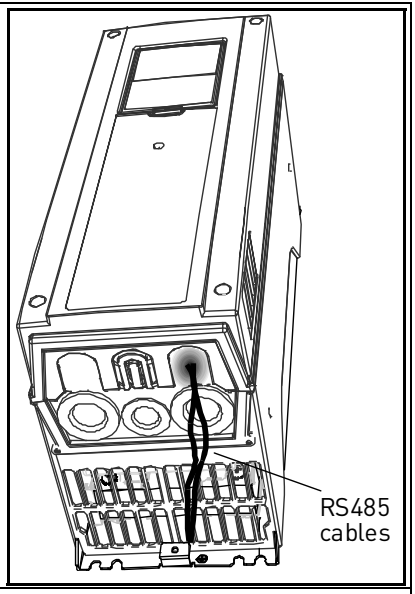
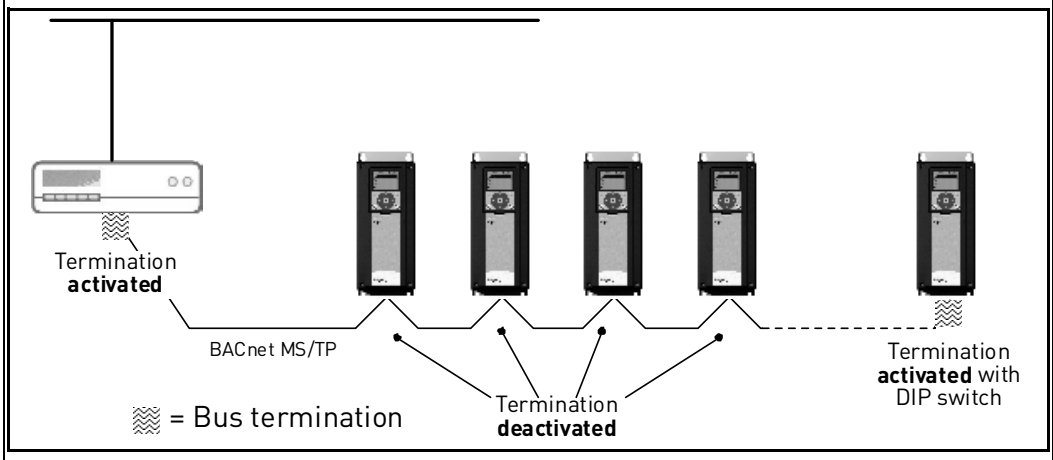


Figure 56.

3	Using the cable clamp included in the delivery of the drive, ground the shield of the RS485 cable to the frame of the drive. 

4	**If the drive is the last device on the bus**, the bus termination must be set. Locate the DIP switches to the right of the control keypad of the drive and turn the switch for the RS485 bus termination resistor to position ON. Biasing is built in the termination resistor. See also step 7 on page 58.  * Bus termination resistor
5	Unless already done for the other control cables, cut free the opening on the drive cover for the RS485 cable (protection class IP21). 

6	Remount the drive cover and run the RS485 cables as shown in picture. **NOTE:** When planning the cable runs, remember to keep the distance between the fieldbus cable and the motor cable at a **minimum of 12 in**.	
7	The bus termination must be set for the first and the last device of the fieldbus line. See picture below. See also step 4 on page 57. We recommend that the first device on the bus and, thus, terminated was the Master device. 	

6.2.3 RS485 cable data

Connector	2.5 mm²
Cable type	STP (Shielded Twisted Pair), type Belden 9841 or similar
Cable length	Depends on the used fieldbus. See respective bus manual.

Table 19. RS485 cable data

6.3 Battery installation for Real Time Clock (RTC)

Enabling the functions of the *Real Time Clock (RTC)* requires that a battery is installed in the Smart VFD HVAC drive.

The place for the battery can be found in all frames left to the control keypad (see Figure 57).

Detailed information on the functions of the *Real Time Clock (RTC)* can be found in the Application Manual.

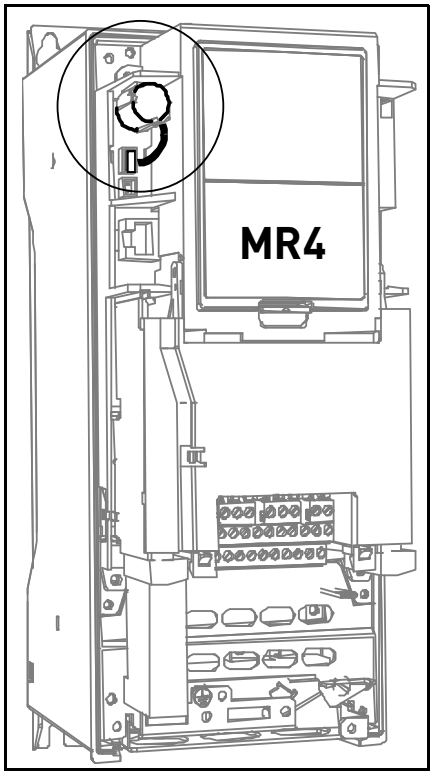


Figure 57. Real Time Clock battery

6.4 Galvanic isolation barriers

The control connections are isolated from the mains potential and the GND terminals are permanently connected to ground. See Figure 58.

The digital inputs are galvanically isolated from the I/O ground. The relay outputs are additionally double-isolated from each other at 300VAC (EN-50178).

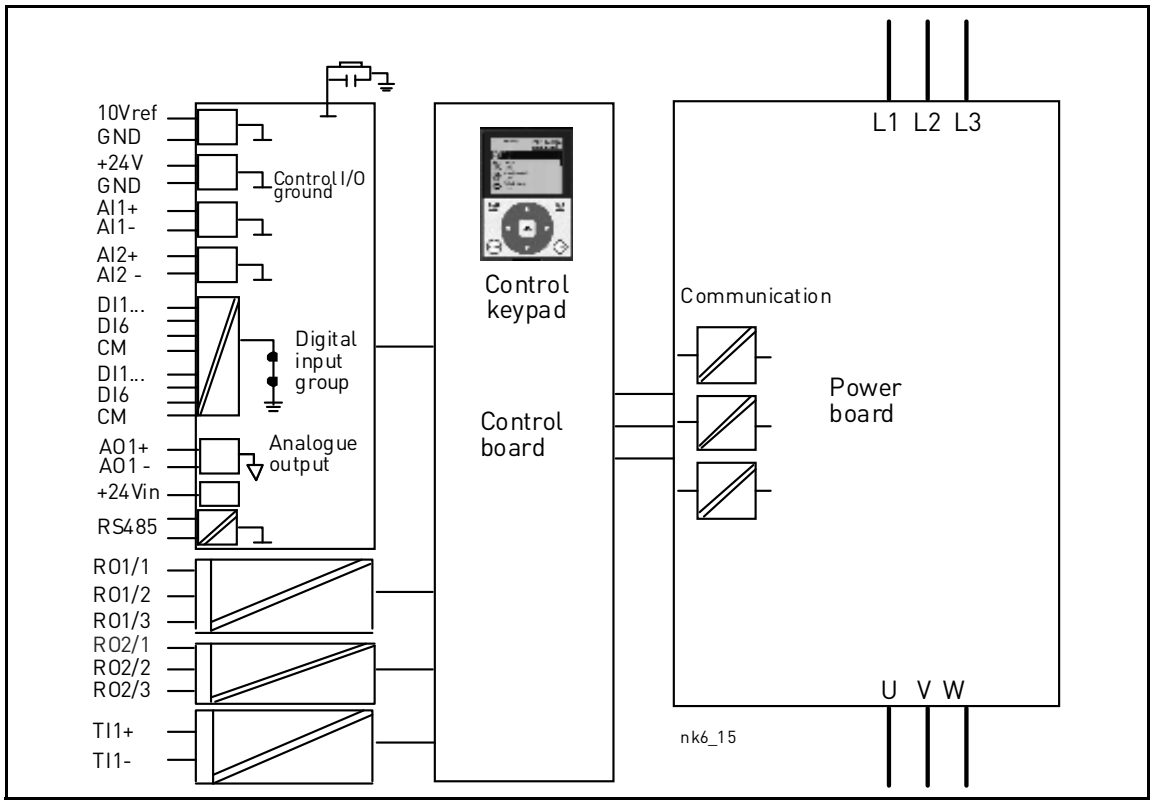


Figure 58. Galvanic isolation barriers

7. PRODUCT DATA

7.1 Power ratings

7.1.1 Mains voltage 208-240 V

Mains voltage 208-240V, 50-60 Hz, 3~					
	Converter type	Loadability		Motor shaft power	
		Low*		230 supply	208-240V supply
		Rated continuous current I_L [A]	10% overload current [A]	10% overload 40°C [kW]	10% overload 40°C [hp]
MR4	A 0007	3.7	4.1	0.55	0.75
	A 0010	4.8	5.3	0.75	1.0
	A 0015	6.6	7.3	1.1	1.5
	A 0020	8.0	8.8	1.5	2.0
	A 0030	11.0	12.1	2.2	3.0
MR5	A 0050	18.0	19.8	4.0	5.0
	A 0075	24.0	26.4	5.5	7.5
	A 0100**	31.0	34.1	7.5	10.0
MR6	A 0150	48.0	52.8	11.0	15.0
	A 0200**	62.0	68.2	15.0	20.0
MR7	A 0250	75.0	82.5	18.5	25.0
	A 0300	88.0	96.8	22.0	30.0
MR8	A 0500	140.0	154.0	37.0	50.0
	A 0600	170.0	187.0	45.0	60.0
	A 0750	205.0	225.5	55.0	75.0
MR9	A 1000	261.0	287.1	75.0	100.0
	A 1250	310.0	341.0	90.0	125.0

* See chapter 7.1.3.

** Given low loadabilities valid for 230V drives at a switching frequency of 4kHz

Table 20. Power ratings, supply voltage 208-240V.

NOTE: The rated currents in given ambient temperatures (in Table 21) are achieved only when the switching frequency is equal to or less than the factory default.

7.1.2 Mains voltage 380-480V

	Mains voltage 380-480V, 50-60 Hz, 3~				
	Converter type	Loadability		Motor shaft power	
		Low*		400V supply	480V supply
		Rated continuous current I_L [A]	10% overload current [A]	10% overload 104°F [kW]	10% overload 104°F [HP]
MR4	C 0015	3.4	3.7	1.1	1.5
	C 0020	4.8	5.3	1.5	2.0
	C 0030	5.6	6.2	2.2	3.0
	C 0050	8.0	8.8	3.0	5.0
	C 0075**	12.0	13.2	5.5	7.5
MR5	C 0100	16.0	17.6	7.5	10
	C 0150	23.0	25.3	11.0	15.0
	C 0200**	31.0	34.1	15.0	20.0
MR6	C 0250	38.0	41.8	18.5	25.0
	C 0300	46.0	50.6	22.0	30.0
	C 0400**	61.0	67.1	30.0	40.0
MR7	C 0500	72.0	79.2	37.0	50.0
	C 0600	87.0	95.7	45.0	60.0
	C 0750	105.0	115.5	55.0	75.0
MR8	C 1000	140.0	154.0	75	100
	C 1250	170.0	187.0	90	125
	C 1500	205.0	225.5	110	150
MR9	C 2000	261.0	287.1	132	200
	C 2500	310.0	341.0	160	250

* See chapter 7.1.3

** Given low loadabilities valid for 480V drives at a switching frequency of 4kHz

Table 20. Power ratings, supply voltage 380-480V.

NOTE: The rated currents in given ambient temperatures (in Table 21) are achieved only when the switching frequency is equal to or less than the factory default.

7.1.3 Definitions of overloadability

Low overload =Following continuous operation at rated output current I_L, the converter is fed with 110% * I_L for 1 min, followed by a period of I_L.

Example: If the duty cycle requires 110% rated current I_L for 1 min in every 10 min, the remaining 9 min must be at rated current or less.

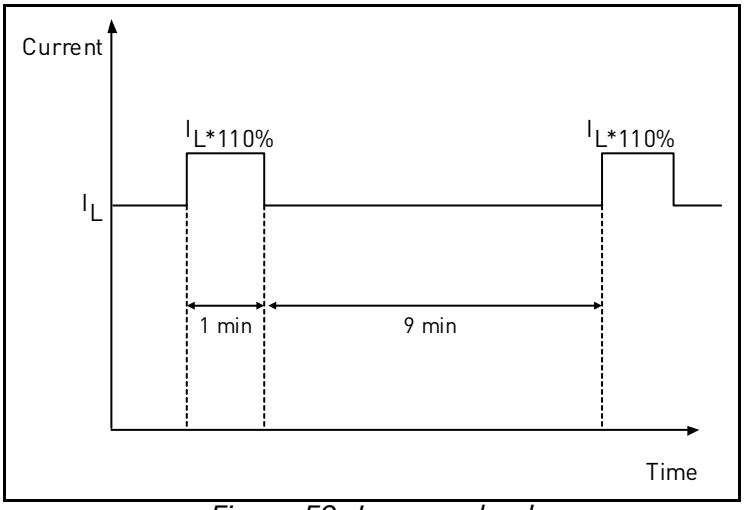


Figure 59. Low overload

7.2 SmartVFD HVAC - technical data

Mains connection	Input voltage U_{in}	208...240V; 380…480V; -10%…+10%
	Input frequency	47…66 Hz
	Connection to mains	Once per minute or less
	Starting delay	4 s (MR4 to MR6); 6 s (MR7 to MR9)
Motor connection	Output voltage	0-U_{in}
	Continuous output current	I_L:Ambient temperature max. +104°F, overload 1.1 x I_L (1 min./10 min.)
	Starting current	I_S for 2 s every 20 s
	Output frequency	0…320 Hz (standard)
	Frequency resolution	0.01 Hz
Control characteristics	Switching frequency (see parameter M3.1.2.1)	1.5…10 kHz; Defaults: 6 kHz (MR4-6), 4 kHz (MR7), 3 kHz (MR8-9) Automatic switching frequency derating in case of overheating
	<u>Frequency reference</u> Analogue input Panel reference	 Resolution 0.1% (10-bit), accuracy ±1% Resolution 0.01 Hz
	Field weakening point	8…320 Hz
	Acceleration time	0.1…3000 sec
	Deceleration time	0.1…3000 sec
Ambient conditions	Ambient operating temperature	I_L : -10°C (no frost)…+40°C
	Storage temperature	-40°F…+158°F
	Relative humidity	0 to 95% R_H, non-condensing, non-corrosive
	Air quality: chemical vapours mechanical particles	 IEC 60721-3-3, unit in operation, class 3C2 IEC 60721-3-3, unit in operation, class 3S2
	Altitude	100% load capacity (no derating) up to 1,000 m 1-% derating for each 100m above 1,000m <u>Max. altitudes:</u> **208...240V:** 4,500m (TN and IT systems) **380...480V:** 4,500m (TN and IT systems) <u>Voltage for I/O signals:</u> Up to 2,000m : Allowed up to **240V** 2,000m...4,500m: Allowed up to **120V**

Ambient conditions (cont.)	Vibration EN61800-5-1/ EN60068-2-6	5…150 Hz **Displacement amplitude** 1 mm (peak) at 5…15.8 Hz (MR4…MR9) **Max acceleration amplitude** 1 G at 15.8…150 Hz (MR4…MR9)
	Shock EN61800-5-1 EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max 15 G, 11 ms (in package)
	Enclosure class	IP21/NEMA 1 standard in entire kW/HP range IP54/NEMA12 option Note! Keypad required for IP54/NEMA12
EMC (at default settings)	Immunity	Fulfils EN61800-3 (2004), first and second environment
	Emissions	Depend on EMC level. +EMC2: EN61800-3 (2004), Category C2 Honeywell Smart VFD HVAC will be delivered with class C2 EMC filtering, if not otherwise specified. Honeywell Smart VFD HVAC can be modified for IT-networks. See chapter 5.2.
Emissions	Average noise level (cooling fan) sound power level in dB(A)	MR4: 65 MR7: 77 MR5: 70 MR8: 86 MR6: 77 MR9: 87
Safety		EN 61800-5-1 (2007), CE, cUL; (see unit nameplate for more detailed approvals)
Control connections	**See chapter 7.2.1.**	
Protections	Overvoltage trip limit Undervoltage trip limit	Yes Yes
	Ground fault protection	In case of ground fault in motor or motor cable, only the drive is protected
	Mains supervision	Yes
	Motor phase supervision	Trips if any of the output phases is missing
	Overcurrent protection	Yes
	Unit overtemperature protection	Yes
Protections (cont.)	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
	Short-circuit protection of +24V and +10V reference voltages	Yes

Table 21. Smart VFD HVAC technical data

7.2.1 Technical information on control connections

Basic I/O board		
Terminal	**Signal**	**Technical information**
1	Reference output	+10V, +3%; Maximum current 10 mA
2	Analogue input, voltage or current	Analogue input channel 1 0- +10V (Ri = 200 kΩ) 4-20 mA (Ri =250 Ω) Resolution 0.1 %, accuracy ±1 % Selection V/mA with dip-switches (see page 52)
3	Analogue input common (current)	Differential input if not connected to ground; Allows ±20V differential mode voltage to GND
4	Analogue input, voltage or current	Analogue input channel 1 Defauit:4-20 mA (Ri =250 Ω) 0-10 V (Ri=200kΩ) Resolution 0.1 %, accuracy ±1 % Selection V/mA with dip-switches (see page 52)
5	Analogue input common (current)	Differential input if not connected to ground; Allows 20V differential mode voltage to GND
6	24V aux. voltage	+24VDC, ±10%, max volt. ripple < 100mVrms; max. 250mA Dimensioning: max. 1000mA/control box. Short-circuit protected
7	I/O ground	Ground for reference and controls (connected internally to frame ground through 1MΩ)
8	Digital input 1	Positive or negative logic Ri = min. 5kΩ 18…30V = "1"
9	Digital input 2	
10	Digital input 3	
11	Common A for DIN1-DIN6	Digital inputs can be disconnected from ground, see chapter 6.1.2.2.
12	24V aux. voltage	+24VDC, ±10%, max volt. ripple < 100mVrms; max. 250mA Dimensioning: max. 1000mA/control box. Short-circuit protected
13	I/O ground	Ground for reference and controls (connected internally to frame ground through 1MΩ)
14	Digital input 4	Positive or negative logic Ri = min. 5kΩ 18…30V = "1"
15	Digital input 5	
16	Digital input 6	
17	Common A for DIN1-DIN6	Digital inputs can be disconnected from ground, see chapter 6.1.2.2.
18	Analogue signal (+output)	Analogue output channel 1, selection 0 -20mA, load <500 Ω Default:0-20 mA 0-10V Resolution 0.1 %, accuracy ±2 % Selection V/mA with dip-switches (see page 52)
19	Analogue output common	
30	24V auxiliary input voltage	Can be used as external power backup for the control unit (and fieldbus)
A	RS485	Differential receiver/transmitter Set bus termination with dip switches (see page 52)
B	RS485	

Table 22. Technical information on basic I/O board

Relay board 1	Relay board with two Type 8A/STST and one Type 8A/STDT relays. 5,5 mm isolation between channels. External interface connector See chapter 6.	
21	Relay output 1*	Switching capacity24VDC/8A 250VAC/8A 125VDC/0.4A Min.switching load5V/10mA
22		
23		
24	Relay output 2*	Switching capacity24VDC/8A 250VAC/8A 125VDC/0.4A Min.switching load5V/10mA
25		
26		
32	Relay output 3*	Switching capacity24VDC/8A 250VAC/8A 125VDC/0.4A Min.switching load5V/10mA
33		

* If 230VAC is used as control voltage from the output relays, the control circuitry must be powered with a separate isolation transformer to limit short circuit current and overvoltage spikes. This is to prevent welding on the relay contacts. Refer to standard EN 60204-1, section 7.2.9

Table 23. Technical information on Relay board 1

Relay board 2	Relay board with two Type 8A/STST and standard thermistor input. 5,5 mm isolation between channels. External interface connector See chapter 6.	
21	Relay output 1*	Switching capacity24VDC/8A 250VAC/8A 125VDC/0.4A Min.switching load5V/10mA
22		
23		
24	Relay output 2*	Switching capacity24VDC/8A 250VAC/8A 125VDC/0.4A Min.switching load5V/10mA
25		
26		
28	Thermistor input	Rtrip = 4.7 kΩ (PTC); Measuring voltage 3.5V
29		

* If 230VAC is used as control voltage from the output relays, the control circuitry must be powered with a separate isolation transformer to limit short circuit current and ovrvoltage spikes. This is to prevent welding on the relay contacts. Refer to standard EN 60204-1, section 7.2.9

Table 24. Technical information on Relay board 2

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1985 Douglas Drive North
Golden Valley, MN 55422
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Application Manual

SmartVFD HVAC

Variable Frequency Drives for Constant and Variable Torque Applications

63-2692-08

INDEX

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1. STARTUP

1.1 Startup Wizard

In the *Startup Wizard*, you will be prompted for essential information needed by the drive so that it can start controlling your process. In the Wizard, you will need the following keypad buttons:

Left/Right arrows. Use these to easily move between digits and decimals.

Up/Down arrows. Use these to move between options in menu and to change value.

OK button. Confirm selection with this button.

Back/Reset button. Pressing this button, you can return to the previous question in the Wizard. If pressed at the first question, the Startup Wizard will be cancelled.

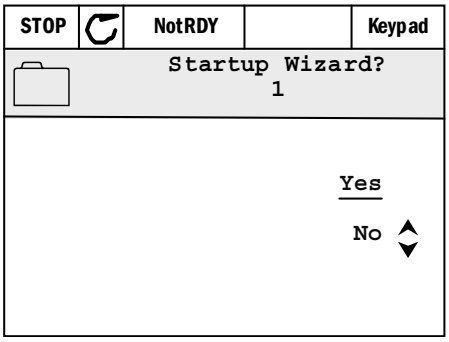
Once you have connected power to the drive, follow these instructions to easily set up your drive.

1	Language selection	Suomi Deutsch English Svenska

2	Daylight saving*	Russia US EU OFF
3	Time*	hh:mm:ss
4	Day*	dd.mm.
5	Year*	yyyy

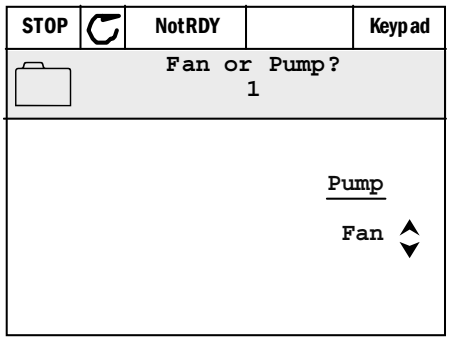
* These questions appear if battery is installed

6	Run Startup Wizard?	Yes No



Push the OK button unless you want to set all parameter values manually.

7	Choose your process	Pump Fan



8	Set value for *Motor Nominal Speed* (according to nameplate)	*Range:* 24...19,200 rpm
9	Set value for *Motor Nominal Current* (according to nameplate)	*Range:* Varies
10	Set value for *Minimum Frequency*	*Range:* 0.00...50.00 Hz
11	Set value for *Maximum Frequency*	*Range:* 0.00...320.00 Hz

Now the Startup Wizard is done.

The Startup Wizard can be re-initiated by activating the parameter *Restore factory defaults* (par. M6.5.1) in the *Parameter backup* submenu (M6.5) OR with parameter M1.19 in the Quick setup menu.

1.2 PID Mini-Wizard

The PID mini wizard is activated in the Quick Setup menu. This wizard presupposes that you are going to use the PID controller in the "one feedback / one setpoint" mode. The control place will be I/O A and the default process unit '%'.

The *PID mini wizard* asks for the following values to be set:

1	Process unit selection	(Several selections. See par. M3.12.1.4)

If any other process unit than '%' is selected the following questions appear: If not the Wizard will directly jump to step 5.

2	Process unit min	
3	Process unit max	
4	Process unit decimals	0...4

5	Feedback 1 source selection	See page 57 for selections.

If one of the analogue input signals is selected the question 6 appears. Otherwise you will be taken to question 7.

6	Analogue input signal range	0 = 0…10V / 0…20mA 1 = 2…10V / 4…20mA See page 42.

7	Error inversion	0 = Normal 1 = Inverted
8	Setpoint source selection	See page 55 for selections.

If one of the analogue input signals is selected the question 9 appears. Otherwise you will be taken to question 11.
If either of the options Keypad Setpoint 1 or 2 is chosen the question 10 will appear.

9	Analogue input signal range	0 = 0…10V / 0…20mA 1 = 2…10V / 4…20mA See page 42.
10	Keypad setpoint	

11	Sleep function?	No Yes

If option 'Yes' is selected you will be prompted for three more values:

12	Sleep frequency limit 1	0.00...320.00 Hz
13	Sleep delay 1	0...3000 s

14	Wake-up level 1	Range depends on selected process unit.

1.3 Multi-pump mini-wizard

The Multi-Pump mini-wizard asks the most important questions for setting up a Multi-Pump system. The PID mini-wizard always precedes the Multi-Pump mini-wizard. The keypad will guide you through the questions as in chapter 1.2 then to be followed by the set of questions below:

15	Number of motors	1...4
16	Interlock function	0 = Not used 1 = Enabled
17	Autochange	0 = Disabled 1 = Enabled

If Autochange function is enabled the following three questions will appear. If Autochange will not be used the Wizard jumps directly to question 21.

18	Include FC	0 = Disabled 1 = Enabled
19	Autochange interval	0.0...3000.0 h
20	Autochange: Frequency limit	0.00...50.00 Hz

21	Bandwidth	0...100%
22	Bandwidth delay	0...3600 s

After this, the keypad will show the digital input and relay output configuration recommended by the application. Write these values down for future reference.

2. GRAPHIC KEYPAD - INTRODUCTION

The control keypad is the interface between the drive and the user. It features an LCD display and 9 buttons.

With the control keypad it is possible to control the speed of a motor, to supervise the state of the equipment and to set the frequency converter's parameters.

2.1 Keypad buttons

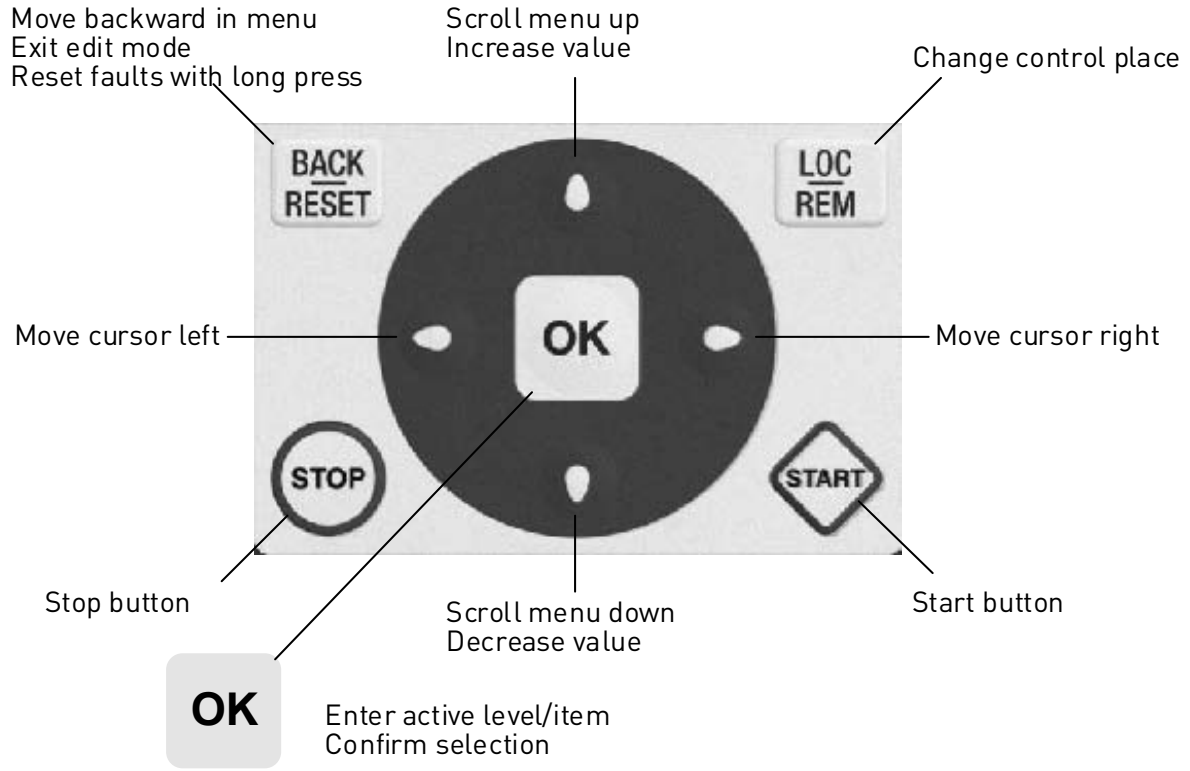


Figure 1. Keypad buttons

2.2 Keypad display

The keypad display indicates the status of the motor and the drive and any irregularities in motor or drive functions. On the display, the user sees information about his present location in the menu structure and the item displayed.

2.2.1 Main menu

The data on the control keypad are arranged in menus and submenus. Use the Up and Down arrows to move between the menus. Enter the group/item by pressing the OK button and return to the former level by pressing the Back/Reset button. See Figure 1.

The *Location field* indicates your current location. The *Status field* gives information about the present status of the drive.

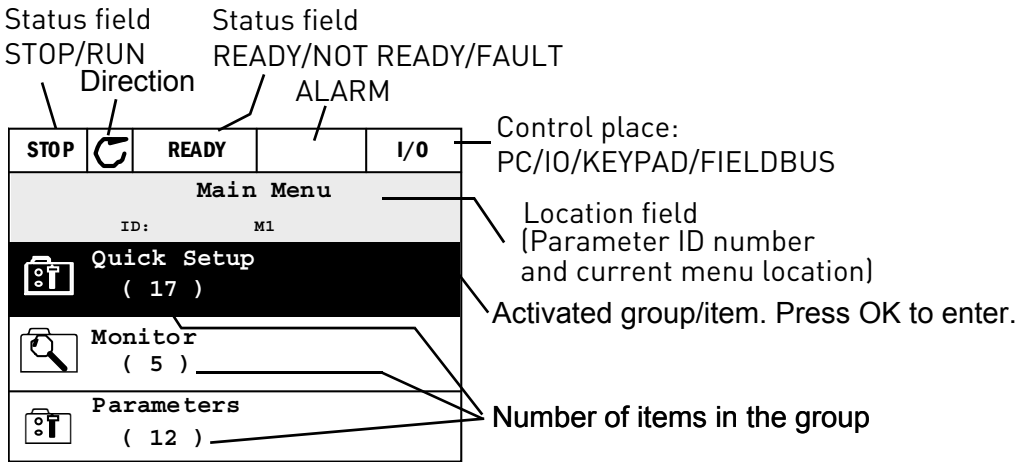


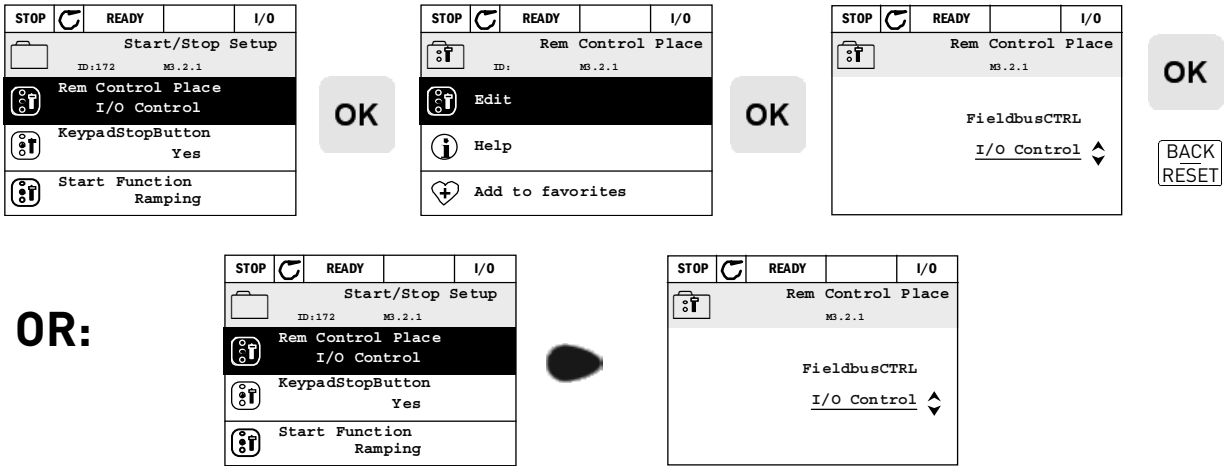
Figure 2. Main menu

2.3 Using the keypad

2.3.1 Editing values

Change value of a parameter following the procedure below:

1. Locate the parameter.
2. Enter the *Edit* mode.
3. Set new value with the arrow buttons up/down. You can also move from digit to digit with the arrow buttons left/right if the value is numerical and change then the value with the arrow buttons up/down.
4. Confirm change with OK button or ignore change by returning to previous level with Back/ Reset button.



2.3.2 Resetting fault

Instructions for how to reset a fault can be found in chapter 3.7.1 on page 87.

2.3.3 Local/remote control button

The LOC/REM button is used for two functions: to quickly access the Control page and to easily change between the Local (Keypad) and Remote control places.

2.3.3.1 Changing the control place

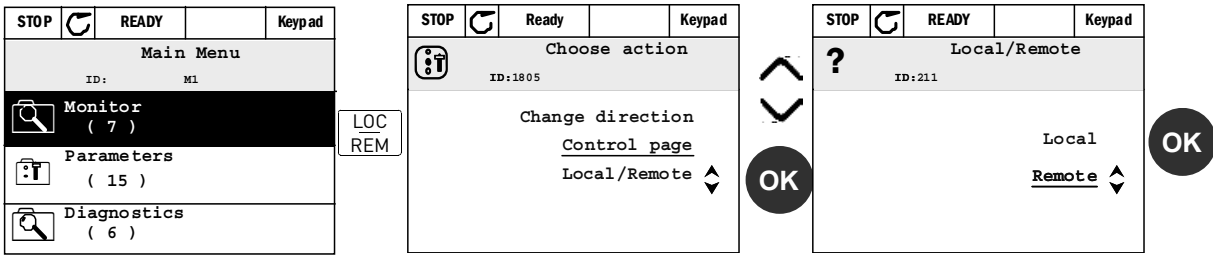
The control place is the source of control where the drive can be started and stopped.

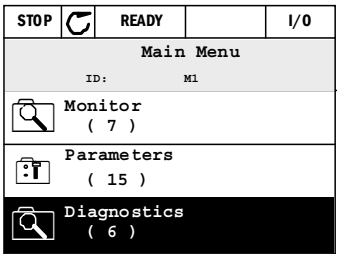
In the HVAC drive, the *Local control place* is always the keypad.

The *Remote control place* is determined by parameter M1.15 (I/O or Fieldbus).

Change of control place from *Remote* to *Local* (keypad).

1. Anywhere in the menu structure, push the *Loc/Rem* button.
2. Push the *Arrow up* or the *Arrow down* button to select *Local/Remote* and confirm with the *OK* button.
3. On the next display, select *Local* or *Remote* and again confirm with the *OK* button.
4. The display will return to the same location as it was when the *Loc/Rem* button was pushed.

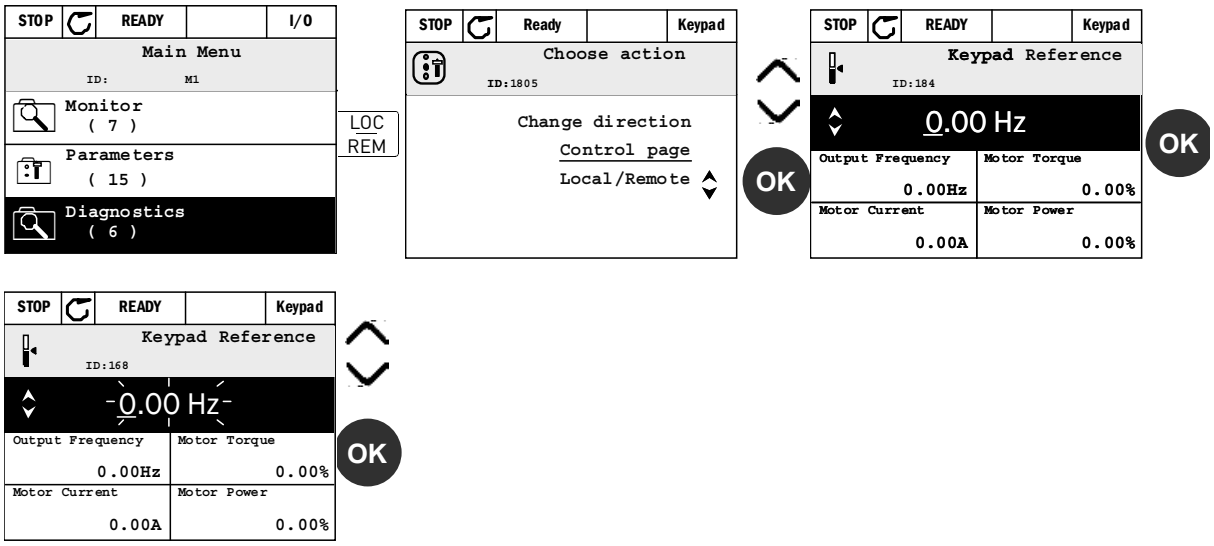




2.3.3.2 Accessing the control page

The *Control page* is meant for easy operation and monitoring of the most essential values.

1. Anywhere in the menu structure, push the *Loc/Rem* button.
2. Push the *Arrow up* or the *Arrow down* button to select *Control page* and confirm with the *OK* button.
3. The control page appears where you can set the *Keypad setpoint 2* after having pressed the OK button. The other values on the page are Multimonitoring values. You can choose which values appear here for monitoring (for this procedure, see page 13).



2.3.4 Help texts

The graphic keypad features instant help and information displays for various items.

All parameters offer an instant help display. Select Help and press the OK button.

Text information is also available for faults, alarms and the startup wizard.

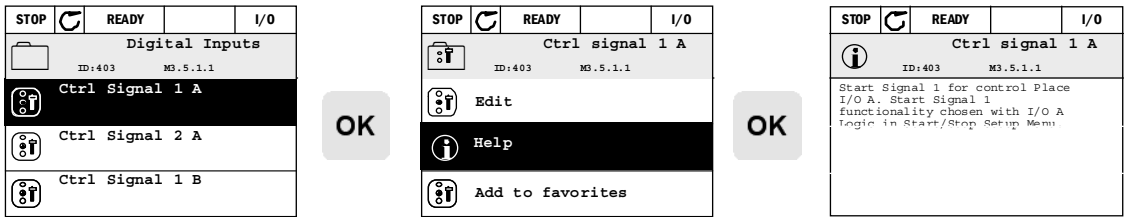


Figure 3. Help text example

2.3.5 Adding item to favourites

You might need to refer to certain parameter values or other items often. Instead of locating them one by one in the menu structure, you may want to add them to a folder called *Favourites* where they can easily be reached.

To remove an item from the Favourites, see chapter 2.4.7.

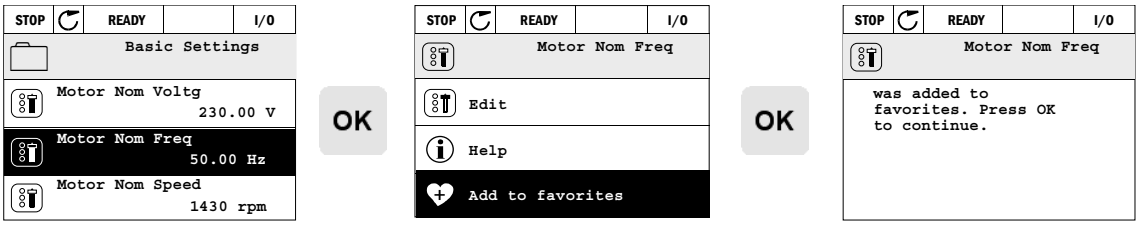


Figure 4. Adding item to Favourites

2.4 Menu structure

Click on and select the item you wish to receive more information about (electronic manual).

Quick setup	See chapter 3.3.
Monitor	Multi-monitor
	Basic
	Timer functions
	PID Controller 1
	PID Controller 2
	Multi-Pump
	Fieldbus data
Parameters	See chapter 3.
Diagnostics	Active faults
	Reset faults
	Fault history
	Total counters
	Trip counters
	Software info
I/O and hard-ware	Basic I/O
	Slot D
	Slot E
	Real time clock
	Keypad
	RS-485
	Ethernet
User settings	Language selections
	Application selection
	Parameter backup
Favourites	See chapter 2.3.5

Table 1. Keypad menus

2.4.1 Quick setup

The Quick Setup Menu includes the minimum set of most commonly used parameters during installation and commissioning. More detailed information on the parameters of this group you will find in chapter 3.3.

2.4.2 Monitor

Multi-monitor

On the multi-monitor page, you can collect nine values that you wish to monitor.

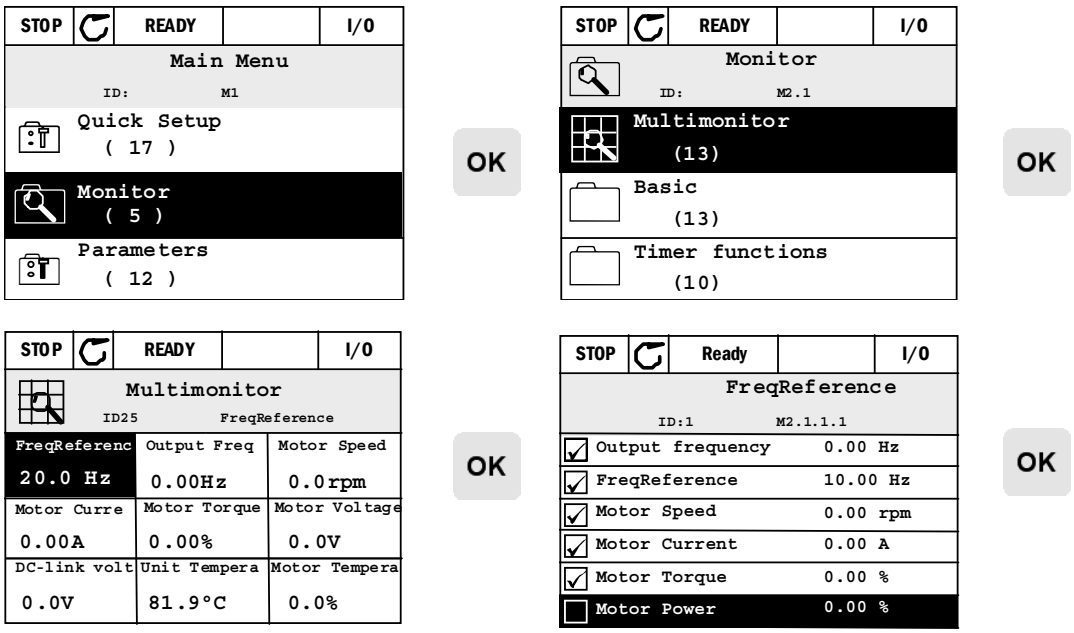


Figure 5. Multi-monitoring page

Change the monitored value by activating the value cell (with arrow buttons left/right) and clicking OK. Then choose a new item on the Monitoring values list and click OK again.

Basic

The basic monitoring values are the actual values of selected parameters and signals as well as statuses and measurements.

Timer functions

Monitoring of timer functions and the Real Time Clock. See chapter 3.4.3.

PID Controller 1

Monitoring of PID controller values. See chapters 3.4.4 and 3.4.5.

PID Controller 2

Monitoring of PID controller values. See chapters 3.4.4 and 3.4.5.

Multi-Pump

Monitoring of values related to the use of several drives. See chapter 3.4.6.

Fieldbus data

Fieldbus data shown as monitor values for debugging purposes at e.g. fieldbus commissioning. See chapter 3.4.8.

2.4.3 Parameters

Through this submenu, you can reach the application parameter groups and parameters. More information on parameters in chapter 3.

2.4.4 Diagnostics

Under this menu, you can find *Active faults*, *Reset faults*, *Fault history*, *Counters* and *Software info.*

2.4.4.1 Active faults

Menu	Function	Note
Active faults	When a fault/faults appear(s), the display with the name of the fault starts to blink. Press OK to return to the Diagnostics menu. The *Active faults* submenu shows the number of faults. Activate the fault and push OK to see the fault-time data.	The fault remains active until it is cleared with the Reset button (push for 2 s) or with a reset signal from the I/O terminal or fieldbus or by choosing *Reset faults* (see below). The memory of active faults can store the maximum of 10 faults in the order of appearance.

2.4.4.2 Reset faults

Menu	Function	Note
Reset faults	In this menu you can reset faults. For closer instructions, see chapter 3.7.1.	⚠ **CAUTION!** Remove external Control signal before resetting the fault to prevent unintentional restart of the drive.

2.4.4.3 Fault history

Menu	Function	Note
Fault history	40 latest faults are stored in the Fault history.	Entering the Fault history and clicking OK on the selected fault shows the fault time data (details).

2.4.4.4 Total counters

Code	Parameter	Min	Max	Unit	Default	ID	Description
M4.4.1	Energy counter			Varies		2291	Amount of energy taken from supply network. No reset.
M4.4.3	Operating time			a d hh:min		2298	Control unit operating time
M4.4.4	Run time			a d hh:min		2293	Motor running time
M4.4.5	Power on time			a d hh:min		2294	Amount of time the power unit has been powered so far. No reset.
M4.4.6	Start command counter					2295	The number of times the power unit has been started.

Table 2. Diagnostics menu, Total counters parameters

2.4.4.5 Trip counters

Code	Parameter	Min	Max	Unit	Default	ID	Description
M4.5.1	Energy counter (+)			Varies		2296	Resettable energy counter.
M4.5.3	Operating time			a d hh:min		2299	Resettable.

Table 3. Diagnostics menu, Trip counters parameters

2.4.4.6 Software info

Code	Parameter	Min	Max	Unit	Default	ID	Description
M4.6.1	Software package						
M4.6.4	System load	0	100	%		2300	Load on control unit CPU.

Table 4. Diagnostics menu, Software info parameters

2.4.5 I/O and hardware

Various options-related settings are located in this menu.

2.4.5.1 Basic I/O

Monitor here the statuses of inputs and outputs.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M5.1.1	Digital input 1	0	1				Status of digital input signal
M5.1.2	Digital input 2	0	1				Status of digital input signal
M5.1.3	Digital input 3	0	1				Status of digital input signal
M5.1.4	Digital input 4	0	1				Status of digital input signal
M5.1.5	Digital input 5	0	1				Status of digital input signal
M5.1.6	Digital input 6	0	1				Status of digital input signal
M5.1.7	Analog input 1 mode	1	5				Analog input signal mode
M5.1.8	Analog input 1	0	100	%			Status of analog input signal
M5.1.9	Analog input 2 mode	1	5				Analog input signal mode
M5.1.10	Analog input 2	0	100	%			Status of analog input signal
M5.1.11	Analog output 1 mode	1	5				Analog output signal mode
M5.1.12	Analog output 1	0	100	%			Status of analog output signal
M5.1.13	Relay output 1	0	1				Status of digital output signal
M5.1.14	Relay output 2	0	1				Status of digital output signal
M5.1.15	Relay output 3	0	1				Status of digital output signal

Table 5. I/O and Hardware menu, Basic I/O parameters

2.4.5.2 Option board slots

The parameters of this group depend on the option board installed. If no option board is placed in slots D or E, no parameters are visible.

Menu	Function	Note
Slot D	Settings	Option board related settings.
	Monitoring	Monitor option board-related info.
Slot E	Settings	Option board related settings.
	Monitoring	Monitor option board-related info.

2.4.5.3 Real time clock

Code	Parameter	Min	Max	Unit	Default	ID	Description
M5.4.1	Battery state	1	3			2205	Status of battery. 1 = Not installed 2 = Installed 3 = Change battery
M5.4.2	Time			hh:mm:ss		2201	Current time of day
M5.4.3	Day			dd.mm.		2202	Current date
M5.4.4	Year			yyyy		2203	Current year
M5.4.5	Daylight saving	0	3		0	2204	Daylight saving rule 0 = Off 1 = EU 2 = US 3 = Russia

Table 6. I/O and Hardware menu, Real time clock parameters

2.4.5.4 Keypad

Code	Parameter	Min	Max	Unit	Default	ID	Description
M5.6.1	Timeout time	0	60	min	0		Time after which the display returns to main menu.
M5.6.2	Contrast	30	70	%	50		Set contrast of the display (30...70%).
M5.6.3	Backlight time	0	60	min	5		Set the time until the back-light of the display turns off (0...60 min). If set to 0 s, backlight is always on.

Table 7. I/O and Hardware menu, Keypad parameters

2.4.5.5 Fieldbus

Parameters related to different fieldbus boards can also be found in the *I/O and Hardware* menu. These parameters are explained in more detail in the respective fieldbus manual.

Submenu level 1	Submenu level 2	Submenu level 3
RS-485	Common settings	Protocol
	Modbus RTU	Modbus parameters
		Modbus monitoring
	N2	N2 parameters
		N2 monitoring
	BACNetMSTP	BACNetMSTP parameters
		BACNetMSTP monitoring
Ethernet	Common settings	
	Modbus/TCP	Modbus/TCP parameters
		Modbus/TCP monitoring

2.4.6 User settings

Code	Parameter	Min	Max	Unit	Default	ID	Description
M6.1	Language selections	1	4			802	1 = English 2 = Suomi 3 = Deutsch 4 = Svenska
M6.2	Application selection						
M6.5	Parameter backup	See chapter 2.4.6.1 below.					
M6.7	Drive name						Give name of drive if needed.

Table 8. User settings menu, General settings

2.4.6.1 Parameter backup

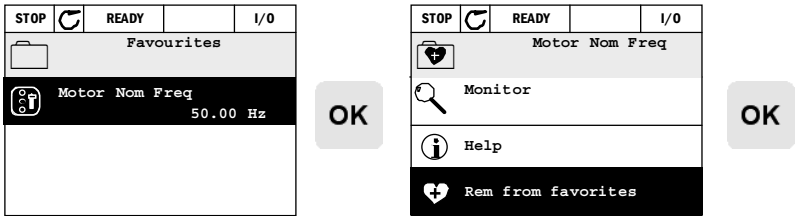
Code	Parameter	Min	Max	Unit	Default	ID	Description
M6.5.1	Restore factory defaults						Restores default parameter values and initiates the Startup Wizard
M6.5.2	Save to keypad	0	1		0		Save parameter values to keypad to e.g. copy them to another drive. 0 = No 1 = Yes
M6.5.3	Restore from keypad						Load parameter values from keypad to the drive.

Table 9. User settings menu, Parameter backup parameters

2.4.7 Favourites

Favourites are typically used to collect a set of parameters or monitoring signals from any of the keypad menus. You can add items or parameters to the Favourites folder, see chapter 2.3.5.

To remove an item or a parameter from the Favourites folder, do the following:



3. HVAC APPLICATION

The drive contains a preloaded application for instant use.

The parameters of this application are listed in chapter 3.5 of this manual and explained in more detail in chapter 3.6.

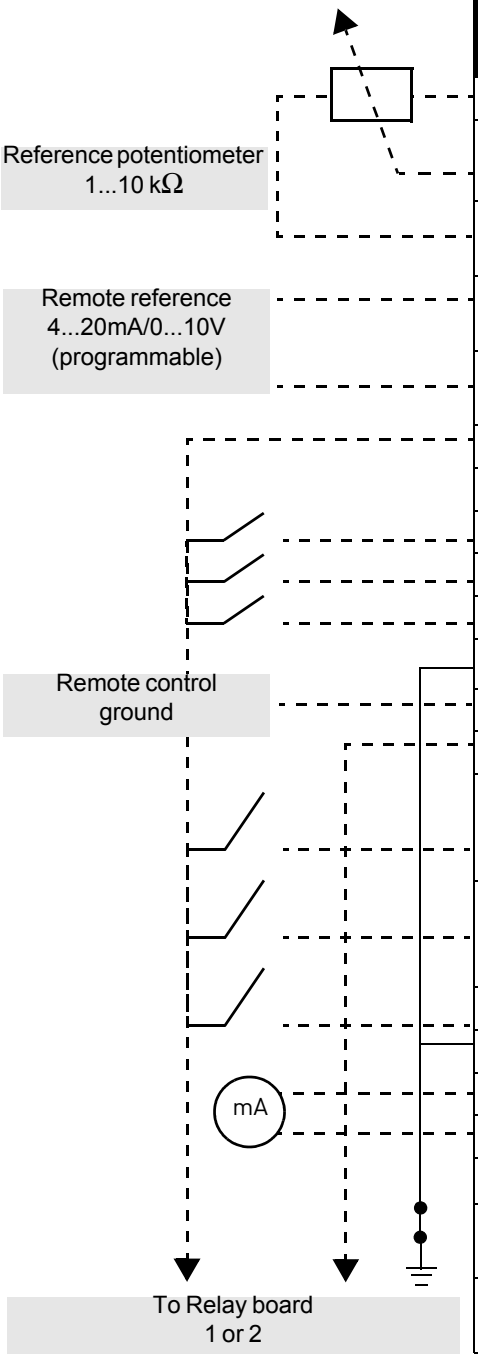
3.1 Specific functions of SmartVFD

The SmartVFD HVAC is an easy-to-use application for basic Pump and Fan applications where only one motor and one drive is needed and also offers extensive possibilities for PID control.

Features

- **Loc/Rem-button** for easy change between Local (keypad) and Remote control place. The remote control place is selectable by parameter (I/O or Fieldbus)
- **Control page** for easy operation and monitoring of the most essential values.
- **Run interlock** input (Damper interlock). Drive will not start before this input is activated.
- Different **pre-heat modes** used to avoid condensation problems
- **Maximum output frequency 320Hz**
- **Real-time clock and timer functions** available (optional battery required). Possible to program 3 time channels to achieve different functions on the drive (e.g. Start/Stop and Preset frequencies)
- **External PID-controller** available. Can be used to control e.g. a valve using the drive's I/O
- **Sleep mode function** which automatically enables and disables drive running with user defined levels to save energy.
- **2-zone PID-controller** (2 different feedback signals; minimum and maximum control)
- **Two setpoint sources** for the PID-control. Selectable with digital input
- **PID setpoint boost function**.
- **Feedforward function** to improve the response to the process changes
- **Process value supervision**
- Multi-Pump control

3.2 Example of control connections



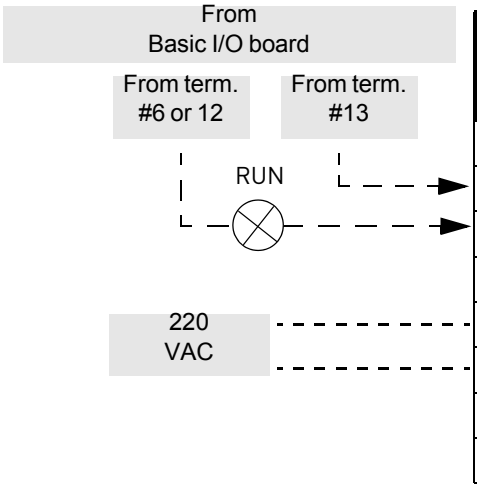
Basic I/O board

Terminal		Signal	Default
1	+10 Vref	Reference output	
2	AI1+	Analog input, voltage or current*	Voltage
3	AI1-	Analog input common (current)	
4	AI2+	Analog input, voltage or current	Current
5	AI2-	Analog input common (current)	
6	24Vout	24V aux. voltage	
7	GND	I/O ground	
8	DI1	Digital input 1	Start FWD
9	DI2	Digital input 2	Start REV
10	DI3	Digital input 3	Fault
11	CM	Common A for DIN1-DIN6**	
12	24Vout	24V aux. voltage	
13	GND	I/O ground	
14	DI4	Digital input 4	Preset freq select 1
15	DI5	Digital input 5	Preset freq select 2
16	DI6	Digital input 6	Fault reset
17	CM	Common A for DIN1-DIN6**	
18	AO1+	Analog signal (+output)	OP freq
19	AO-/GND	Analog output common	
30	+24 Vin	24V auxiliary input voltage	
A	RS485	Differential receiver/transmitter	
B	RS485	Differential receiver/transmitter	

*Selectable with DIP switches, see Installation Manual

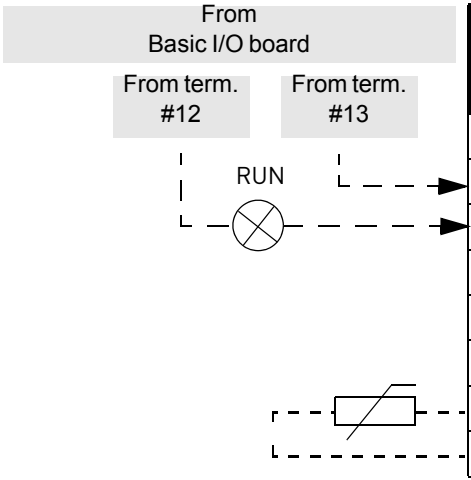
**Digital inputs can be disconnected from ground. See Installation Manual.

Table 10. Connection example, basic I/O board



Relay board 1				
Terminal			Signal	
21	RO1/1 NC		Relay output 1	RUN
22	RO1/2 CM			
23	RO1/3 NO			
24	RO2/1 NC		Relay output 2	FAULT
25	RO2/2 CM			
26	RO2/3 NO			
32	RO3/1 CM		Relay output 3	READY
33	RO3/2 NO			

Table 11. Connection example, Relay board 1



Relay board 2				
Terminal			Signal	
21	RO1/1 NC		Relay output 1	RUN
22	RO1/2 CM			
23	RO1/3 NO			
24	RO2/1 NC		Relay output 2	FAULT
25	RO2/2 CM			
26	RO2/3 NO			
28	TI1+		Thermistor input	
29	TI1-			

Table 12. Connection example, Relay board 2

3.3 HVAC Application - Quick setup parameter group

The Quick Setup parameter group is a collection of parameters that are most commonly used during installation and commissioning. They are collected in the first parameter group so that they can be found fast and easily. They can, however, be also reached and edited in their actual parameter groups. Changing a parameter value in the Quick setup group also changes the value of this parameter in its actual group.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M1.1	Motor nominal voltage	Varies	Varies	V	Varies	110	Find this value U_n on the rating plate of the motor. See page 33.
M1.2	Motor nominal frequency	8.00	320.00	Hz	60.00	111	Find this value f_n on the rating plate of the motor. See page 33.
M1.3	Motor nominal speed	24	19200	rpm	1720	112	Find this value n_n on the rating plate of the motor.
M1.4	Motor nominal current	Varies	Varies	A	Varies	113	Find this value I_n on the rating plate of the motor.
M1.5	Motor Cos Phi	0.30	1.00		0.80	120	Find this value on the rating plate of the motor
M1.6	Motor nominal power	0.00	Varies	kW	Varies	116	Find this value I_n on the rating plate of the motor.
M1.7	Motor current limit	Varies	Varies	A	Varies	107	Maximum motor current from AC drive
M1.8	Minimum frequency	0.00	M3.3.1	Hz	Varies	101	Minimum allowed frequency reference
M1.9	Maximum frequency	M3.3.1	320.00	Hz	60.00	102	Maximum allowed frequency reference
M1.10	I/O control reference A selection	1	8		7	117	Selection of ref source when control place is I/O A. See page 36 for selections.
M1.11	Preset frequency 1	M3.3.1	300.00	Hz	10.00	105	Select with digital input: Preset frequency selection 0 (M3.5.1.16)
M1.12	Preset frequency 2	M3.3.1	300.00	Hz	15.00	106	Select with digital input: Preset frequency selection 1 (M3.5.1.17)
M1.13	Acceleration time 1	0.1	3000.0	s	20.0	103	Time to accelerate from zero to maximum frequency
M1.14	Deceleration time 1	0.1	3000.0	s	20.0	104	Time to decelerate from minimum to zero frequency
M1.15	Remote control place	1	2		1	172	Selection of remote control place (start/stop) 1 = I/O 2 = Fieldbus
M1.16	Automatic reset	0	1		0	731	0 = Disabled 1 = Enabled
M1.17	PID Mini-Wizard	0	1		0	1803	0 = Inactive 1 = Activate See chapter 1.2.

M1.18	Multi-Pump Wizard	0	1		0		0 = Inactive 1 = Activate See chapter 1.3.
M1.19	Startup Wizard	0	1		0		0 = Inactive 1 = Activate See chapter 1.1.

Table 13. Quick setup parameter group

3.4 Monitor group

The drive provides you with a possibility to monitor the actual values of parameters and signals as well as statuses and measurements. Some of the values to be monitored are customizable.

3.4.1 Multimonitor

On the multi-monitor page, you can collect nine values that you wish to monitor. See page 13 for more information.

3.4.2 Basic

See Table 14 in which the basic monitoring values are presented.

NOTE!

Only Basic I/O board statuses are available in the Monitor menu. Statuses for all I/O board signals can be found as raw data in the I/O and Hardware system menu.

Check expander I/O board statuses when required in the I/O and Hardware system menu.

	Monitoring value	Unit	ID	Description
M2.2.1	Output frequency	Hz	1	Output frequency to motor
M2.2.2	Frequency reference	Hz	25	Frequency reference to motor control
M2.2.3	Motor speed	rpm	2	Motor speed in rpm
M2.2.4	Motor current	A	3	
M2.2.5	Motor torque	%	4	Calculated shaft torque
M2.2.7	Motor shaft power	%	5	Total power consumption of AC drive
M2.2.8	Motor shaft power	kW/hp	73	
M2.2.9	Motor voltage	V	6	
M2.2.10	DC link voltage	V	7	
M2.2.11	Unit temperature	°C	8	Heatsink temperature
M2.2.12	Motor temperature	%	9	Calculated motor temperature
M2.2.13	Analog input 1	%	59	Signal in percent of used range
M2.2.14	Analog input 2	%	60	Signal in percent of used range
M2.2.15	Analog output 1	%	81	Signal in percent of used range
M2.2.16	Motor preheat		1228	0 = OFF 1 = Heating (feeding DC-current)
M2.2.17	Drive Status Word		43	Bit coded status of drive B1=Ready B2=Run B3=Fault B6=RunEnable B7=AlarmActive B10=DC Current in stop B11=DC Brake Active B12=RunRequest B13=MotorRegulatorActive
M2.2.18	Last active fault		37	The fault code of latest activated fault that has not been reset.

	Monitoring value	Unit	ID	Description
M2.2.19	Fire mode status		1597	0=Disabled 1=Enabled 2=Activated (Enabled + DI open) 3=Test mode
M2.2.20	DIN Status Word 1		56	16-bit word where each bit represents the status of one digital input. 6 digital inputs at every slot are read. Word 1 starts from input 1 in slot A (bit0) and goes to input 4 in slot C (bit15).
M2.2.21	DIN Status Word 2		57	16-bit word where each bit represents the status of one digital input. 6 digital inputs at every slot are read. Word 2 starts from input 5 in slot C (bit0) and goes to input 6 in slot E (bit13).

Table 14. Monitoring menu items

3.4.3 Timer functions monitoring

Here you can monitor values of timer functions and the Real Time Clock.

	Monitoring value	Unit	ID	Description
M2.3.1	TC 1, TC 2, TC 3		1441	Possible to monitor the statuses of the three Time Channels (TC)
M2.3.2	Interval 1		1442	Status of timer interval
M2.3.3	Interval 2		1443	Status of timer interval
M2.3.4	Interval 3		1444	Status of timer interval
M2.3.5	Interval 4		1445	Status of timer interval
M2.3.6	Interval 5		1446	Status of timer interval
M2.3.7	Timer 1	s	1447	Remaining time on timer if active
M2.3.8	Timer 2	s	1448	Remaining time on timer if active
M2.3.9	Timer 3	s	1449	Remaining time on timer if active
M2.3.10	Real time clock		1450	

Table 15. Monitoring of timer functions

3.4.4 PID1 controller monitoring

	Monitoring value	Unit	ID	Description
M2.4.1	PID1 setpoint	Varies	20	Process units selected with parameter
M2.4.2	PID1 feedback	Varies	21	Process units selected with parameter
M2.4.3	PID1 error value	Varies	22	Process units selected with parameter
M2.4.4	PID1 output	%	23	Output to motor control or external control (AO)
M2.4.5	PID1 status		24	0=Stopped 1=Running 3=Sleep mode 4=In dead band (see page 54)

Table 16. PID1-controller value monitoring

3.4.5 PID2 controller monitoring

	Monitoring value	Unit	ID	Description
M2.5.1	PID2 setpoint	Varies	83	Process units selected with parameter
M2.5.2	PID2 feedback	Varies	84	Process units selected with parameter
M2.5.3	PID2 error value	Varies	85	Process units selected with parameter
M2.5.4	PID2 output	%	86	Output to external control (AO)
M2.5.5	PID2 status		87	0=Stopped 1=Running 2=In dead band (see page 54)

Table 17. PID2-controller value monitoring

3.4.6 Pump and Fan Cascade (PFC)

	Monitoring value	Unit	ID	Description
M2.6.1	Motors running		30	The number of motors running when Multi-Pump function is used.
M2.6.2	Autochange		1113	Informs the user if autochange is requested.

Table 18. Pump and fan cascade monitoring

3.4.7 Maintenance timers

	Monitoring value	Unit	ID	Description
M2.7.1	Counter 1	h/revs	1101	Status of counter (Revs*1000 or hours)
M2.7.2	Counter 2	h/revs	1102	Status of counter (Revs*1000 or hours)
M2.7.3	Counter 3	h/revs	1103	Status of counter (Revs*1000 or hours)

Table 19. Maintenance timers monitoring

3.4.8 Fieldbus data monitoring

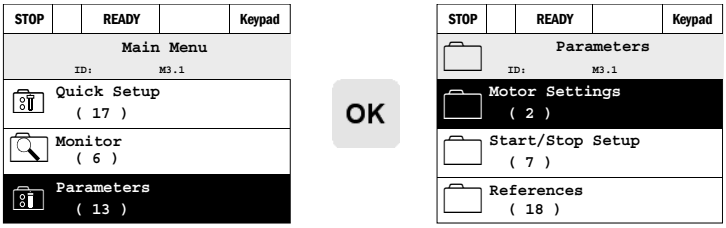
	Monitoring value	Unit	ID	Description
M2.8.1	FB Control Word		874	Fieldbus control word used by application in bypass mode/format. Depending on the fieldbus type or profile the data can be modified before sent to application.
M2.8.2	FB speed reference		875	Speed reference scaled between minimum and maximum frequency at the moment it was received by the application. Minimum and maximum frequencies can changed after the reference was received without affecting the reference.
M2.8.3	FB data in 1		876	Raw value of process data in 32-bit signed format
M2.8.4	FB data in 2		877	Raw value of process data in 32-bit signed format
M2.8.5	FB data in 3		878	Raw value of process data in 32-bit signed format
M2.8.6	FB data in 4		879	Raw value of process data in 32-bit signed format
M2.8.7	FB data in 5		880	Raw value of process data in 32-bit signed format
M2.8.8	FB data in 6		881	Raw value of process data in 32-bit signed format
M2.8.9	FB data in 7		882	Raw value of process data in 32-bit signed format
M2.8.10	FB data in 8		883	Raw value of process data in 32-bit signed format
M2.8.11	FB Status Word		864	Fieldbus status word sent by application in bypass mode/format. Depending on the FB type or profile the data can be modified before sent to the FB.
M2.8.12	FB speed actual		865	Actual speed in %. 0 and 100% correspond to minimum and maximum frequencies respectively. This is continuously updated depending on the momentary min and max frequencies and the output frequency.
M2.8.13	FB data out 1		866	Raw value of process data in 32-bit signed format
M2.8.14	FB data out 2		867	Raw value of process data in 32-bit signed format
M2.8.15	FB data out 3		868	Raw value of process data in 32-bit signed format
M2.8.16	FB data out 4		869	Raw value of process data in 32-bit signed format

	Monitoring value	Unit	ID	Description
M2.8.17	FB data out 5		870	Raw value of process data in 32-bit signed format
M2.8.18	FB data out 6		871	Raw value of process data in 32-bit signed format
M2.8.19	FB data out 7		872	Raw value of process data in 32-bit signed format
M2.8.20	FB data out 8		873	Raw value of process data in 32-bit signed format

Table 20. Fieldbus data monitoring

3.5 HVAC Application - Application parameter lists

Find the parameter menu and the parameter groups as guided below.



The HVAC Application embodies the following parameter groups:

Menu and Parameter group	Description
Group 3.1: Motor settings	Basic and advanced motor settings
Group 3.2: Start/Stop setup	Start and stop functions
Group 3.3: Control reference settings	Frequency reference setup
Group 3.4: Ramp & Brakes Setup	Acceleration/Deceleration setup
Group 3.5: I/O Configuration	I/O programming
Group 3.6: Fieldbus Data Mapping	Process data in/out mapping
Group 3.7: Prohibit Frequencies	Prohibit frequencies programming
Group 3.8: Limit supervisions	Programmable limit controllers
Group 3.9: Protections	Protections configuration
Group 3.10: Automatic reset	Auto reset after fault configuration
Group 3.11: Timer functions	Configuration of 3 timers based on Real Time Clock.
Group 3.12: PID-controller 1	Parameters for PID Controller 1. Motor control or external usage.
Group 3.13: PID-controller 2	Parameters for PID Controller 2. External usage.
Group 3.14: Pump and Fan Cascade	Parameters for Pump and Fan Cascade.
Group 3.15: Maintenance counters	Parameters for Maintenance counters.
Group 3.16: Fire mode	Parameters for Fire Mode.

Table 21. Parameter groups

3.5.1 Column explanations

Code = Location indication on the keypad; Shows the operator the parameter number.
Parameter = Name of parameter
Min = Minimum value of parameter
Max = Maximum value of parameter
Unit = Unit of parameter value; Given if available
Default = Value preset by factory
ID = ID number of the parameter
Description = Short description of parameter values or its function
☞ = More information on this parameter available; Click the parameter name

3.5.2 Parameter programming

The programming of digital inputs is very flexible. There are no digital terminals assigned only for certain function. You can choose the terminal of your choice for the certain function, in other words, functions appear as parameters which the operator defines a certain input for.

Also *Time Channels* can be assigned to digital inputs. See more information on page 52.

3.5.2.1 Example programming

The selectable values of the programmable parameters are of type

DigIN SlotA.1

in which

'DigIN' stands for digital input.
'Slot_' refers to the board; **A** and **B** are basic boards, **D** and **E** are option boards (see Figure 6).
The parameter (signal) is not connected to any terminal, i.e. it is not used, if, instead of a letter, the word Slot is followed by a **'0'** (for example **DigIN Slot0.1**).
The number after the board letter refers to the respective terminal on the selected board.
Hence, **SlotA.1** means terminal DIN1 on the basic board in board slot A.

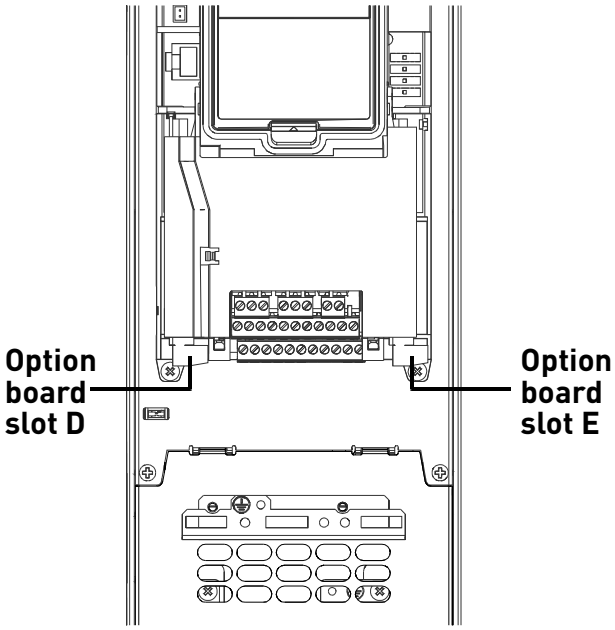
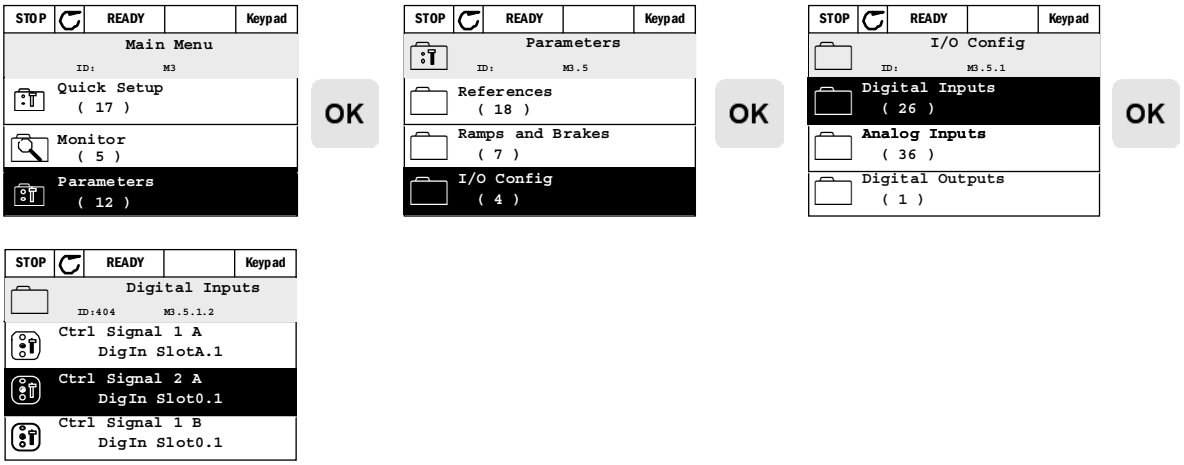


Figure 6. Option board slots

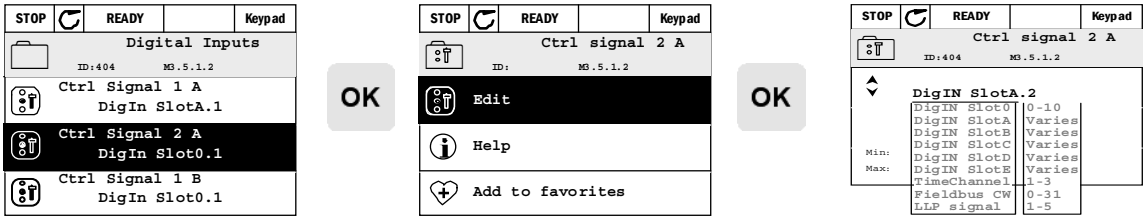
EXAMPLE:

You want to connect the *Control signal 2 A* **(parameter M3.5.1.2) to digital input DI2 on Basic I/O board.**

1	Locate the parameter *Control signal 2 A* (M3.5.1.2) on the keypad.



2	Enter the *Edit* mode.



3	**Change the value:** The editable part of the value (DigIN Slot0) is underlined and blinking. Change the slot or assign the signal to Time Channel with the arrow keys up and down. Make the terminal value (.1) editable by pressing the right key once and change the value with arrow keys up and down. Accept the change with OK button or return to previous menu level with BACK/ RESET button.

3.5.3 Group 3.1: Motor settings

3.5.3.1 Basic Settings

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.1.1.1	Motor nominal voltage	Varies	Varies	V	Varies	110	Find this value U_n on the rating plate of the motor. This parameter sets the voltage at the field weakening point to 100% * U_{nMotor}. Note also used connection (Delta/Star).
M3.1.1.2	Motor nominal frequency	8.00	320.00	Hz	60.00	111	Find this value f_n on the rating plate of the motor.
M3.1.1.3	Motor nominal speed	24	19200	rpm	1720	112	Find this value n_n on the rating plate of the motor.
M3.1.1.4	Motor nominal current	Varies	Varies	A	Varies	113	Find this value I_n on the rating plate of the motor.
M3.1.1.5	Motor Cos Phi	0.30	1.00		0.80	120	Find this value on the rating plate of the motor
M3.1.1.6	Motor nominal power	Varies	Varies	kW	Varies	116	Find this value In on the rating plate of the motor.
M3.1.1.7	Motor current limit	Varies	Varies	A	Varies	107	Maximum motor current from drive
M3.1.1.8	Supply voltage	Varies	Varies	V	Varies	1200	

Table 22. Basic motor settings

3.5.3.2 Motor Control Settings

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.1.2.1	Switching frequency	1.5	Varies	kHz	Varies	601	Motor noise can be minimised using a high switching frequency. Increasing the switching frequency reduces the capacity of the drive. It is recommended to use a lower frequency when the motor cable is long in order to minimize capacitive currents in the cable.
M3.1.2.3	Motor preheat function	0	3		0	1225	0 = Not used 1 = Always in stop state 2 = Controlled by DI 3 = Temperature limit (heatsink) **NOTE:** Virtual digital input can be activated by RTC
M3.1.2.4	Motor preheat temperature limit	-20	80	°C	0	1226	Motor preheat is switched on when the heatsink temperature goes below this level (if par. M3.1.2.3 is set to *Temperature limit*. If limit is e.g. 10°C feeding current starts at 10 °C and stops at 11°C (1-degree hysteresis).
M3.1.2.5	Motor preheat current	0	$0.5*I_L$	A	Varies	1227	DC current for pre-heating of motor and drive in stop state. Activated by digital input or by temperature limit.

Table 23. Advanced motor settings

3.5.4 Group 3.2: Start/Stop setup

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.2.1	Remote control place	0	1		0	172	Selection of remote control place (start/stop). Can be used to change back to remote control from PC e.g. in case of a broken panel. 0=I/O control 1=Fieldbus control
M3.2.2	Local/Remote	0	1		0	211	Switch between local and remote control places 0=Remote 1=Local
M3.2.3	Keypad stop button	0	1		0	114	0=Stop button always enabled (Yes) 1=Limited function of Stop button (No)
M3.2.4	Start function	0	1		0	505	0=Ramping 1=Flying start
M3.2.5	Stop function	0	1		0	506	0=Coasting 1=Ramping
M3.2.6	I/O A start/stop logic	0	3		0	300	**CtrlSgn 1** 0=Start fwd 1=Start fwd pulse(3-wire) 2=Start fwd pulse 3=AI1 threshold **CrtlSgn 2** 0=Start fwd 1=Stop pulse (3-wire) 2=Start fwd pulse 3=AI1 threshold
M3.2.7	I/O B start/stop logic	0	3		0	363	See above.
M3.2.8	AI1 start threshold	3.00	100.00	%	5.00	185	If M3.2.6 (I/O Start/Stop Logic) is set to value 3 (AI1 threshold) the motor will start at the level set with parameter this parameter and stop at the same -2% AI1 can also be used as frequency reference at the same time.
M3.2.9	Fieldbus start logic	0	1		1	889	0=Rising edge required 1=State
M3.2.10	Keypad Master Stop	0	1		1	1806	0=Disable 1=Enable

Table 24. Start/Stop Setup menu

3.5.5 Group 3.3: Control reference settings

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.3.1	Minimum frequency	0.00	M3.3.2	Hz	0.00	101	Minimum allowed frequency reference
M3.3.2	Maximum frequency	M3.3.1	320.00	Hz	60.00	102	Maximum allowed frequency reference
M3.3.3	I/O control reference A selection	1	8		6	117	Selection of ref source when control place is I/O A 1 = Preset Frequency 0 2 = Keypad reference 3 = Fieldbus 4 = AI1 5 = AI2 6 = AI1+AI2 7 = PID 1 reference 8 = Motor potentiometer
M3.3.4	I/O control reference B selection	1	8		4	131	Selection of ref source when control place is I/O B. See above. **NOTE**: I/O B control place can only be forced active with digital input (M3.5.1.5).
M3.3.5	Keypad Ctrl Reference selection	1	8		2	121	Selection of ref source when control place is keypad: 1 = Preset Frequency 0 2 = Keypad 3 = Fieldbus 4 = AI1 5 = AI2 6 = AI1+AI2 7 = PID 1 reference 8 = Motor potentiometer
M3.3.6	Keypad reference	0.00	M3.3.2	Hz	0.00	184	The frequency reference can be adjusted on the keypad with this parameter.
M3.3.7	Keypad direction	0	1		0	123	Motor rotation when control place is keypad 0 = Forward 1 = Reverse
M3.3.8	Keypad reference copy	0	2		1	181	Selects function for Run state & Reference copy when changing to Keypad control: 0 = Copy reference 1 = Copy ref & Run State 2 = No copying
M3.3.9	Fieldbus control reference selection	1	8		3	122	Selection of ref source when control place is Fieldbus: 1 = Preset frequency 0 2 = Keypad 3 = Fieldbus 4 = AI1 5 = AI2 6 = AI1+AI2 7 = PID 1 reference 8 = Motor potentiometer

M3.3.10	Preset frequency mode	0	1		0	182	0 = Binary coded 1 = Number of inputs. Preset frequency is selected according to how many of preset speed digital inputs are active
M3.3.11	Preset frequency 0	M3.3.1	M3.3.2	Hz	5.00	180	Basic preset frequency 0 when selected by Control reference parameter (M3.3.3).
M3.3.12	Preset frequency 1	M3.3.1	M3.3.2	Hz	10.00	105	Select with digital input: Preset frequency selection 0 (M3.5.1.16)
M3.3.13	Preset frequency 2	M3.3.1	M3.3.2	Hz	15.00	106	Select with digital input: Preset frequency selection 1 (M3.5.1.17)
M3.3.14	Preset frequency 3	M3.3.1	M3.3.2	Hz	20.00	126	Select with digital inputs: Preset frequency selection 0 & 1
M3.3.15	Preset frequency 4	M3.3.1	M3.3.2	Hz	25.00	127	Select with digital input: Preset frequency selection 2 (M3.5.1.18)
M3.3.16	Preset frequency 5	M3.3.1	M3.3.2	Hz	30.00	128	Select with digital inputs: Preset frequency selection 0 & 2
M3.3.17	Preset frequency 6	M3.3.1	M3.3.2	Hz	40.00	129	Select with digital inputs: Preset frequency selection 1 & 2
M3.3.18	Preset frequency 7	M3.3.1	M3.3.2	Hz	50.00	130	Select with digital inputs: Preset frequency selection 0 & 1 & 2
M3.3.19	Preset alarm frequency	M3.3.1	M3.3.2	Hz	25.00	183	This frequency used when fault response (in Group 3.9: Protections) is Alarm+preset frequency
M3.3.20	Motor potentiometer ramp time	0.1	500.0	Hz/s	10.0	331	Rate of change in the motor potentiometer reference when increased or decreased.
M3.3.21	Motor potentiometer reset	0	2		1	367	Motor potentiometer frequency reference reset logic. 0 = No reset 1 = Reset if stopped 2 = Reset if powered down

Table 25. Control reference settings

3.5.6 Group 3.4: Ramp & Brakes Setup

Two ramps are available (two sets of acceleration time, deceleration time and ramp shape). The second ramp can be activated by a frequency threshold or a digital input. **NOTE:** Ramp 2 always has higher priority and is used if a digital input for ramp selection is activated or Ramp 2 threshold is smaller than RampFreqOut.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.4.1	Ramp 1 shape	0.0	10.0	s	0.0	500	S-curve time ramp 1
M3.4.2	Acceleration time 1	0.1	300.0	s	Varies	103	Defines the time required for the output frequency to increase from zero frequency to maximum frequency
M3.4.3	Deceleration time 1	0.1	300.0	s	Varies	104	Defines the time required for the output frequency to decrease from maximum frequency to zero frequency
M3.4.4	Ramp 2 threshold	0.00	M3.3.2	Hz	0.00	526	Ramp 2 is activated when output frequency exceeds this limit (compared to frequency output from ramp generator). 0=Not in use. Ramp 2 can also be forced with a digital input.
M3.4.5	Ramp 2 shape	0.0	10.0	s	0.0	501	See M3.4.1.
M3.4.6	Acceleration time 2	0.0	300.0	s	10.0	502	See M3.4.2.
M3.4.7	Deceleration time 2	0.0	300.0	s	10.0	503	See M3.4.3.
M3.4.8	Ramp time optimizer	0	1		Varies	1808	0=Disable 1=Enable
M3.4.9	Ramp optimizing percentage	0.0	50.0	%	10.0	1809	Defines how big step changes in acceleration and deceleration times are allowed. 10.0% means that when running against the overvoltage controller at ramp down, the deceleration time is increased with 10.0% of the momentary value.
M3.4.10	Ramp optimizing max time	0.0	3000.0	s	Varies	1810	Ramp time optimizer does not increase the ramp over this limit.
M3.4.11	Start magnetizing time	0,00	600,00	s	0,00	516	This parameter defines the time for how long DC current is fed to motor before acceleration starts.
M3.4.12	Start magnetizing current	Varies	Varies	A	Varies	517	
M3.4.13	DC braking time at stop	0,00	600,00	s	0,00	508	Determines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping.

M3.4.14	DC brake current	Varies	Varies	A	Varies	507	Defines the current injected into the motor during DC-braking. 0 = Disabled
M3.4.15	Frequency to start DC braking at ramp stop	0,10	10,00	Hz	1,50	515	The output frequency at which the DC-braking is applied.
M3.4.16	Flux braking	0	1		0	520	0=Disabled 1=Enabled
M3.4.17	Flux braking current	0	Varies	A	Varies	519	Defines the current level for flux braking.

Table 26. Ramp and brakes setup

3.5.7 Group 3.5: I/O Configuration

3.5.7.1 Digital inputs

Digital inputs are very flexible to use. Parameters are functions that are connected to the required digital input terminal. The digital inputs are represented as, for example, *DigIN Slot A.2,* meaning the second input on slot A.

It's also possible to connect the digital inputs to time channels which are also represented as terminals.

Code	Parameter	Default	ID	Description
M3.5.1.1	Control signal 1 A	DigIN SlotA.1	403	Start signal 1 when control place is I/O 1 (FWD)
M3.5.1.2	Control signal 2 A	DigIN Slot0.1	404	Start signal 2 when control place is I/O 1 (REV)
M3.5.1.3	Control signal 1 B	DigIN Slot0.1	423	Start signal 1 when control place is I/O B
M3.5.1.4	Control signal 2 B	DigIN Slot0.1	424	Start signal 2 when control place is I/O B
M3.5.1.5	I/O B control force	DigIN Slot0.1	425	TRUE = Force the control place to I/O B
M3.5.1.6	I/O B reference force	DigIN Slot0.1	343	TRUE = Used frequency reference is specified by I/O reference B parameter (M3.3.4).
M3.5.1.7	External fault close	DigIN SlotA.3	405	FALSE = OK TRUE = External fault
M3.5.1.8	External fault open	DigIN Slot0.2	406	FALSE = External fault TRUE = OK
M3.5.1.9	Fault reset	DigIN SlotA.6	414	Resets all active faults
M3.5.1.10	Run enable	DigIN Slot0.2	407	Must be on to set drive in Ready state
M3.5.1.11	Run interlock 1	DigIN Slot0.1	1041	Drive may be ready but start is blocked as long as interlock is on (Damper interlock).
M3.5.1.12	Run interlock 2	DigIN Slot0.1	1042	As above.
M3.5.1.13	Acceleration/Deceleration time selection	DigIN Slot0.1	408	Used for switching between ramps 1 and 2. FALSE=Ramp 1 shape, Acceleration time 1 and Deceleration time 1. TRUE=Ramp 2 shape, Acceleration time 2 and Deceleration time 2.
M3.5.1.14	Motor preheat ON	DigIN Slot0.1	1044	FALSE = No action TRUE = Uses the motor preheat DC-Current in Stop state Used when parameter M3.1.2.3 is set to 2.
M3.5.1.15	Fire Mode activation	DigIN Slot0.2	1596	FALSE = Fire Mode active TRUE = No action
M3.5.1.16	Preset frequency selection 0	DigIN SlotA.4	419	Binary selector for Preset frequencies (0-7). See page 37.
M3.5.1.17	Preset frequency selection 1	DigIN SlotA.5	420	Binary selector for Preset frequencies (0-7). See page 37.
M3.5.1.18	Preset frequency selection 2	DigIN Slot0.1	421	Binary selector for Preset frequencies (0-7). See page 37.
M3.5.1.19	Timer 1	DigIN Slot0.1	447	Rising edge starts Timer 1 programmed in Group 3.11: Timer functions parameter group
M3.5.1.20	Timer 2	DigIN Slot0.1	448	See above
M3.5.1.21	Timer 3	DigIN Slot0.1	449	See above
M3.5.1.22	PID1 setpoint boost	DigIN Slot0.1	1047	FALSE = No boost TRUE = Boost

M3.5.1.23	PID1 select setpoint	DigIN Slot0.1	1046	FALSE = Setpoint 1 TRUE = Setpoint 2
M3.5.1.24	PID2 start signal	DigIN Slot0.2	1049	FALSE = PID2 in stop mode TRUE = PID2 regulating This parameter will have no effect if PID2 controller is not enabled in the Basic menu for PID2
M3.5.1.25	PID2 select setpoint	DigIN Slot0.1	1048	FALSE = Setpoint 1 TRUE = Setpoint 2
M3.5.1.26	Motor 1 interlock	DigIN Slot0.1	426	FALSE = Not active TRUE = Active
M3.5.1.27	Motor 2 interlock	DigIN Slot0.1	427	FALSE = Not active TRUE = Active
M3.5.1.28	Motor 3 interlock	DigIN Slot0.1	428	FALSE = Not active TRUE = Active
M3.5.1.29	Motor 4 interlock	DigIN Slot0.1	429	FALSE = Not active TRUE = Active
M3.5.1.30	Motor potentiometer UP	DigIN Slot0.1	418	FALSE = Not active TRUE = Active (Motor potentiometer reference INCREASES until the contact is opened)
M3.5.1.31	Motor potentiometer DOWN	DigIN Slot0.1	417	FALSE = Not active TRUE = Active (Motor potentiometer reference DECREASES until the contact is opened)
M3.5.1.32	Reset Maintenance counter 1	DigIN Slot0.1	490	TRUE = Reset
M3.5.1.33	Reset Maintenance counter 2	DigIN Slot0.1	491	TRUE = Reset
M3.5.1.34	Reset Maintenance counter 3	DigIN Slot0.1	492	TRUE = Reset

Table 27. Digital input settings

3.5.7.2 Analog inputs

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.5.2.1	AI1 signal selection				AnIN SlotA.1	377	Connect the AI1 signal to the analog input of your choice with this parameter. Programmable.
M3.5.2.2	AI1 signal filter time	0.00	300.00	s	0.1	378	Filter time for analog input
M3.5.2.3	AI1 signal range	0	1		0	379	0 = 0…10V / 0…20mA 1 = 2…10V / 4…20mA
M3.5.2.4	AI1 custom. min	-160.00	160.00	%	0.00	380	Custom range min setting 20% = 4-20 mA/2-10 V
M3.5.2.5	AI1 custom. max	-160.00	160.00	%	100.00	381	Custom range max setting
M3.5.2.6	AI1 signal inversion	0	1		0	387	0 = Normal 1 = Signal inverted
M3.5.2.7	AI2 signal selection				AnIN SlotA.2	388	See M3.5.2.1.
M3.5.2.8	AI2 signal filter time	0.00	300.00	s	0.1	389	See M3.5.2.2.
M3.5.2.9	AI2 signal range	0	1		1	390	0 = 0…10V / 0…20mA 1 = 2…10V / 4…20mA
M3.5.2.10	AI2 custom. min	-160.00	160.00	%	0.00	391	See M3.5.2.4.
M3.5.2.11	AI2 custom. max	-160.00	160.00	%	100.00	392	See M3.5.2.5.
M3.5.2.12	AI2 signal inversion	0	1		0	398	See M3.5.2.6.
M3.5.2.13	AI3 signal selection				AnIN Slot0.1	141	Connect the AI3 signal to the analog input of your choice with this parameter. Programmable.
M3.5.2.14	AI3 signal filter time	0.00	300.00	s	0.1	142	Filter time for analog input
M3.5.2.15	AI3 signal range	0	1		0	143	0 = 0…10V / 0…20mA 1 = 2…10V / 4…20mA
M3.5.2.16	AI3 custom. min	-160.00	160.00	%	0.00	144	20% = 4-20 mA/2-10 V
M3.5.2.17	AI3 custom. max	-160.00	160.00	%	100.00	145	Custom range max setting
M3.5.2.18	AI3 signal inversion	0	1		0	151	0 = Normal 1 = Signal inverted
M3.5.2.19	AI4 signal selection				AnIN Slot0.1	152	See M3.5.2.13. Programmable.
M3.5.2.20	AI4 signal filter time	0.00	300.00	s	0.1	153	See M3.5.2.14.
M3.5.2.21	AI4 signal range	0	1		0	154	0 = 0…10V / 0…20mA 1 = 2…10V / 4…20mA
M3.5.2.22	AI4 custom. min	-160.00	160.00	%	0.00	155	See M3.5.2.16.
M3.5.2.23	AI4 custom. max	-160.00	160.00	%	100.00	156	See M3.5.2.17.
M3.5.2.24	AI4 signal inversion	0	1		0	162	See M3.5.2.18.
M3.5.2.25	AI5 signal selection				AnIN Slot0.1	188	Connect the AI5 signal to the analog input of your choice with this parameter. Programmable.
M3.5.2.26	AI5 signal filter time	0.00	300.00	s	0.1	189	Filter time for analog input
M3.5.2.27	AI5 signal range	0	1		0	190	0 = 0…10V / 0…20mA 1 = 2…10V / 4…20mA
M3.5.2.28	AI5 custom. min	-160.00	160.00	%	0.00	191	20% = 4-20 mA/2-10 V
M3.5.2.29	AI5 custom. max	-160.00	160.00	%	100.00	192	Custom range max setting

M3.5.2.30	AI5 signal inversion	0	1		0	198	0 = Normal 1 = Signal inverted
M3.5.2.31	AI6 signal selection				AnIN Slot0.1	199	See M3.5.2.13. Programmable.
M3.5.2.32	AI6 signal filter time	0.00	300.00	s	0.1	200	See M3.5.2.14.
M3.5.2.33	AI6 signal range	0	1		0	201	0 = 0…10V / 0…20mA 1 = 2…10V / 4…20mA
M3.5.2.34	AI6 custom. min	-160.00	160.00	%	0.00	202	See M3.5.2.16.
M3.5.2.35	AI6 custom. max	-160.00	160.00	%	100.00	203	See M3.5.2.17.
M3.5.2.36	AI6 signal inversion	0	1		0	209	See M3.5.2.18.

Table 28. Analog input settings

3.5.7.3 Digital outputs, slot B (Basic)

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.5.3.2.1	Basic R01 function	0	35		2	11001	Function selection for Basic R01: 0 = None 1 = Ready 2 = Run 3 = General fault 4 = General fault inverted 5 = General alarm 6 = Reversed 7 = At speed 8 = Motor regulator active 9 = Preset speed active 10 = Keypad control active 11 = I/O B control activated 12 = Limit supervision 1 13 = Limit supervision 2 14 = Start signal active 15 = Reserved 16 = Fire Mode activation 17 = RTC time chnl 1 control 18 = RTC time chnl 2 control 19 = RTC time chnl 3 control 20 = FB ControlWord B13 21 = FB ControlWord B14 22 = FB ControlWord B15 23 = PID1 in Sleep mode 24 = Reserved 25 = PID1 supervision limits 26 = PID2 supervision limits 27 = Motor 1 control 28 = Motor 2 control 29 = Motor 3 control 30 = Motor 4 control 31 = Reserved (Always open) 32 = Reserved (Always open) 33 = Reserved (Always open) 34 = Maintenance alarm 35 = Maintenance fault
M3.5.3.2.2	Basic R01 ON delay	0.00	320.00	s	0.00	11002	ON delay for relay
M3.5.3.2.3	Basic R01 OFF delay	0.00	320.00	s	0.00	11003	OFF delay for relay
M3.5.3.2.4	Basic R02 function	0	35		3	11004	See M3.5.3.2.1
M3.5.3.2.5	Basic R02 ON delay	0.00	320.00	s	0.00	11005	See M3.5.3.2.2.
M3.5.3.2.6	Basic R02 OFF delay	0.00	320.00	s	0.00	11006	See M3.5.3.2.3.
M3.5.3.2.7	Basic R03 function	0	35		1	11007	See M3.5.3.2.1. Not visible if only 2 output relays are installed

Table 29. Digital output settings on basic I/O board

3.5.7.4 Expander slots D and E digital outputs

Code	Parameter	Min	Max	Unit	Default	ID	Description
	Application dynamic output list						Shows only parameters for existing outputs in slot D/E. Selections as in Basic R01 Not visible if no digital output exists in slot D/E.

Table 30. Slot D/E digital outputs

3.5.7.5 Analog outputs, Slot A (Basic)

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.5.4.1.1	AO1 function	0	19		2	10050	0=TEST 0% (Not used) 1=TEST 100% 2=Output freq (0 -fmax) 3=Freq reference (0-fmax) 4=Motor speed (0 - Motor nominal speed) 5=Output current (0-I_{nMotor}) 6=Motor torque (0-T_{nMotor}) 7=Motor power (0-P_{nMotor}) 8=Motor voltage (0-U_{nMotor}) 9=DC link voltage (0-1000V) 10=PID1 output (0-100%) 11=PID2 output (0-100%) 12=ProcessDataIn1 13=ProcessDataIn2 14=ProcessDataIn3 15=ProcessDataIn4 16=ProcessDataIn5 17=ProcessDataIn6 18=ProcessDataIn7 19=ProcessDataIn8 **NOTE:** For ProcessDataIn, e.g. value 5000 = 50.00%
M3.5.4.1.2	AO1 filter time	0.00	300.00	s	1.00	10051	Filtering time of analog output signal. See M3.5.2.2 0 = No filtering
M3.5.4.1.3	AO1 minimum	0	1		0	10052	0 = 0 mA / 0V 1 = 4 mA / 2V Note the difference in analog output scaling in parameter M3.5.4.1.4.
M3.5.4.1.4	AO1 minimum scale	Varies	Varies	Varies	0.0	10053	Min scale in process unit (depends on selection of AO1 function)
M3.5.4.1.5	AO1 maximum scale	Varies	Varies	Varies	0.0	10054	Max scale in process unit (depends on selection of AO1 function)

Table 31. Basic I/O board analog output settings

3.5.7.6 Expander slots D to E analog outputs

Code	Parameter	Min	Max	Unit	Default	ID	Description
	Application dynamic output list						Shows only parameters for existing outputs in slot D/E. Selections as in Basic AO1 Not visible if no analog output exists in slot D/E.

Table 32. Slot D/E analog outputs

3.5.8 Group 3.6: Fieldbus Data Mapping

Code	Parameter	Min	Max	Unit	Default	ID	Description
P3.6.1	Fieldbus data out 1 selection	0	35000		1	852	Data sent to fieldbus can be chosen with parameter and monitor value ID numbers. The data is scaled to unsigned 16-bit format according to the format on keypad. E.g. 25.5 on keypad equals 255.
P3.6.2	Fieldbus data out 2 selection	0	35000		2	853	Select Process Data Out with parameter ID
P3.6.3	Fieldbus data out 3 selection	0	35000		3	854	Select Process Data Out with parameter ID
P3.6.4	Fieldbus data out 4 selection	0	35000		4	855	Select Process Data Out with parameter ID
P3.6.5	Fieldbus data out 5 selection	0	35000		5	856	Select Process Data Out with parameter ID
P3.6.6	Fieldbus data out 6 selection	0	35000		6	857	Select Process Data Out with parameter ID
P3.6.7	Fieldbus data out 7 selection	0	35000		7	858	Select Process Data Out with parameter ID
P3.6.8	Fieldbus data out 8 selection	0	35000		37	859	Select Process Data Out with parameter ID

Table 33. Fieldbus data mapping

3.5.9 Group 3.7: Prohibit Frequencies

In some systems it may be necessary to avoid certain frequencies due to mechanical resonance problems. By setting up prohibit frequencies it is possible to skip these ranges.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.7.1	Prohibit frequency range 1 low limit	-1,00	320,00	Hz	0,00	509	0 = Not used
M3.7.2	Prohibit frequency range 1 high limit	0,00	320,00	Hz	0,00	510	0 = Not used
M3.7.3	Prohibit frequency range 2 low limit	0,00	320,00	Hz	0,00	511	0 = Not used
M3.7.4	Prohibit frequency range 2 high limit	0,00	320,00	Hz	0,00	512	0 = Not used
M3.7.5	Prohibit frequency range 3 low limit	0,00	320,00	Hz	0,00	513	0 = Not used
M3.7.6	Prohibit frequency range 3 high limit	0,00	320,00	Hz	0,00	514	0 = Not used
M3.7.7	Ramp time factor	0,1	10,0	Times	1,0	518	Multiplier of the currently selected ramp time between prohibit frequency limits.
M3.7.8	Resonance sweep acc/dec time	0.1	3000.0	s	20.0	1812	Acceleration and deceleration times to be used during resonance sweep.

Table 34. Prohibit frequencies

3.5.10 Group 3.8: Limit supervisions

Choose here:

1. One or two (M3.8.1/M3.8.5) signal values for supervision.
2. Whether the low or high limits are supervised (M3.8.2/M3.8.6)
3. The actual limit values (M3.8.3/M3.8.7).
4. The hystereses for the set limit values (M3.8.4/M3.8.8).

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.8.1	Supervision #1 item selection	0	7		0	1431	0 = Output frequency 1 = Frequency reference 2 = Motor current 3 = Motor torque 4 = Motor power 5 = DC-link voltage 6 = Analog input 1 7 = Analog input 2
M3.8.2	Supervision #1 mode	0	2		0	1432	0 = Not used 1 = Low limit supervision (output active over limit) 2 = High limit supervision (output active under limit)
M3.8.3	Supervision #1 limit	-200.000	200.000	Varies	25.00	1433	Supervision limit for selected item. Unit appears automatically.
M3.8.4	Supervision #1 limit hysteresis	-200.000	200.000	Varies	5.00	1434	Supervision limit hysteresis for selected item. Unit is set automatically.
M3.8.5	Supervision #2 item selection	0	7		1	1435	See M3.8.1
M3.8.6	Supervision #2 mode	0	2		0	1436	See M3.8.2
M3.8.7	Supervision #2 limit	-200.000	200.000	Varies	40.00	1437	See M3.8.3
M3.8.8	Supervision #2 limit hysteresis	-200.000	200.000	Varies	5.00	1438	See M3.8.4

Table 35. Limits supervision settings

3.5.11 Group 3.9: Protections

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.9.1	Response to Analog input low fault	0	4		0	700	0=No action 1=Alarm 2=Alarm, set preset fault frequency (par. M3.3.19) 3=Fault (Stop according to stop mode) 4=Fault (Stop by coasting)
M3.9.2	Response to external fault	0	3		2	701	0 = No action 1 = Alarm 2 = Fault (Stop according to stop mode) 3 = Fault (Stop by coasting)
M3.9.3	Response to Input phase fault	0	3		3	730	See above
M3.9.4	Undervoltage fault	0	1		0	727	0 = Fault stored in history 1 = Fault not stored in history
M3.9.5	Response to output phase fault	0	3		2	702	See M3.9.2
M3.9.6	Motor thermal protection	0	3		2	704	See M3.9.2
M3.9.7	Motor ambient temperature factor	-20.0	100.0	°C	40.0	705	Ambient temperature in °C
M3.9.8	Motor thermal zero speed cooling	5.0	150.0	%	Varies	706	Defines the cooling factor at zero speed in relation to the point where the motor is running at nominal speed without external cooling.
M3.9.9	Motor thermal time constant	1	200	min	Varies	707	The time constant is the time within which the calculated thermal stage has reached 63% of its final value.
M3.9.10	Motor thermal loadability factor	0	150	%	100	708	
M3.9.11	Motor stall fault	0	3		0	709	See M3.9.2
M3.9.12	Underload fault (broken belt/dry pump)	0	3		0	713	See M3.9.2
M3.9.13	Response to Fieldbus communication fault	0	4		3	733	See M3.9.1
M3.9.14	Slot communication fault	0	3		2	734	See M3.9.2
M3.9.15	Thermistor fault	0	3		0	732	See M3.9.2
M3.9.16	Soft fill timeout	0	3		2	748	See M3.9.2
M3.9.17	Response to PID1 supervision fault	0	3		2	749	See M3.9.2
M3.9.18	Response to PID2 supervision fault	0	3		2	757	See M3.9.2

Table 36. Protections settings

3.5.12 Group 3.10: Automatic reset

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.10.1	Automatic reset	0	1		0	731	0 = Disabled 1 = Enabled
M3.10.2	Restart function	0	1		1	719	The start mode for Automatic reset is selected with this parameter: 0 = Flying start 1 = According to par. M3.2.4
M3.10.3	Wait time	0,10	10000,0	s	0,50	717	Wait time before the first reset is executed.
M3.10.4	Trial time	0,00	10000,0	s	60,00	718	When the trial time has elapsed, and the fault is still active, the drive will trip to fault.
M3.10.5	Number of trials	1	10		4	759	NOTE: Total number of trials (irrespective of fault type)
M3.10.6	Autoreset: Undervoltage	0	1		1	720	Autoreset permitted? 0 = No 1 = Yes
M3.10.7	Autoreset: Overvoltage	0	1		1	721	Autoreset permitted? 0 = No 1 = Yes
M3.10.8	Autoreset: Overcurrent	0	1		1	722	Autoreset permitted? 0 = No 1 = Yes
M3.10.9	Autoreset: AI low	0	1		1	723	Autoreset permitted? 0 = No 1 = Yes
M3.10.10	Autoreset: Unit over-temperature	0	1		1	724	Autoreset permitted? 0 = No 1 = Yes
M3.10.11	Autoreset: Motor over-temperature	0	1		1	725	Autoreset permitted? 0 = No 1 = Yes
M3.10.12	Autoreset: External fault	0	1		0	726	Autoreset permitted? 0 = No 1 = Yes
M3.10.13	Autoreset: Underload fault	0	1		0	738	Autoreset permitted? 0 = No 1 = Yes

Table 37. Autoreset settings

3.5.13 Group 3.11: Timer functions

The functions of this parameter group can be made the fullest advantage of if the Real Time Clock settings have been properly made during the Startup Wizard (see page 2 and page 3).

You can program the up to five incidents to take place between set points of time (*Intervals*) and additionally three timer-based functions to last for a set period of time.

Intervals and Timers are assigned to the three available *Time Channels* .

Example of programming: You want to apply *Preset frequency 1* **(M3.3.11, set to use with parameter M3.5.1.15,** *Preset frequency selection 0***) Mondays, from 08:00 until 16:00 hrs .**

1. Set the parameters for *Interval 1* **(3.11.1):**
M3.11.1.3: *From day*: '**1**' (=Monday)
M3.11.1.1: *ON time*: '**0800**'

M3.11.1.2: *OFF time*: '**1600**'
M3.11.1.4: *To day*: '**1**' (=Monday)

M3.11.1.5: *Assign to channel*: '**1**' (= Time Channel 1)

2. Then assign the selected Time channel to a digital input using the programming method described in chapter 3.5.2.
Go to menu *Parameters* (M3), further down to menu *I/O config* (M3.5) and *Digital inputs* (M3.5.1). Locate the parameter *Preset frequency selection 0* (M3.5.1.15). Change the value of this parameter to *TimeChannel.1*.

Now the function *Preset frequency selection 0* is activated at 08:00 on Monday and deactivated at 16:00 the same day.

The status of the Intervals and Time channels can be monitored in Menu M2.3.

Code	Parameter	Min	Max	Unit	Default	ID	Description
3.11.1 INTERVAL 1							
M3.11.1.1	ON time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1464	ON time
M3.11.1.2	OFF time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1465	OFF time
M3.11.1.3	From day	0	6		0	1466	ON day of week 0=Sunday 1=Monday 2=Tuesday 3=Wednesday 4=Thursday 5=Friday 6=Saturday
M3.11.1.4	To day	0	6		0	1467	See above
M3.11.1.5	Assign to channel	0	3		0	1468	Select affected time channel (1-3) 0=Not used 1=Time channel 1 2=Time channel 2 3=Time channel 3
3.11.2 INTERVAL 2							
M3.11.2.1	ON time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1469	See Interval 1
M3.11.2.2	OFF time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1470	See Interval 1
M3.11.2.3	From day	0	6		0	1471	See Interval 1

M3.11.2.4	To day	0	6		0	1472	See Interval 1
M3.11.2.5	Assign to channel	0	3		0	1473	See Interval 1
3.11.3 INTERVAL 3							
M3.11.3.1	ON time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1474	See Interval 1
M3.11.3.2	OFF time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1475	See Interval 1
M3.11.3.3	From day	0	6		0	1476	See Interval 1
M3.11.3.4	To day	0	6		0	1477	See Interval 1
M3.11.3.5	Assign to channel	0	3		0	1478	See Interval 1
3.11.4 INTERVAL 4							
M3.11.4.1	ON time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1479	See Interval 1
M3.11.4.2	OFF time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1480	See Interval 1
M3.11.4.3	From day	0	6		0	1481	See Interval 1
M3.11.4.4	To day	0	6		0	1482	See Interval 1
M3.11.4.5	Assign to channel	0	3		0	1483	See Interval 1
3.11.5 INTERVAL 5							
M3.11.5.1	ON time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1484	See Interval 1
M3.11.5.2	OFF time	00:00:00	23:59:59	hh:mm:ss	00:00:00	1485	See Interval 1
M3.11.5.3	From day	0	6		0	1486	See Interval 1
M3.11.5.4	To day	0	6		0	1487	See Interval 1
M3.11.5.5	Assign to channel	0	3		0	1488	See Interval 1
3.11.6 TIMER 1							
M3.11.6.1	Duration	0	72000	s	0	1489	The time the timer will run when activated. (Activated by DI)
M3.11.6.2	Assign to channel	0	3		0	1490	Select affected time channel (1-3) 0=Not used 1=Time channel 1 2=Time channel 2 3=Time channel 3
3.11.7 TIMER 2							
M3.11.7.1	Duration	0	72000	s	0	1491	See Timer 1
M3.11.7.2	Assign to channel	0	3		0	1492	See Timer 1
3.11.8 TIMER 3							
M3.11.8.1	Duration	0	72000	s	0	1493	See Timer 1
M3.11.8.2	Assign to channel	0	3		0	1494	See Timer 1

Table 38. Timer functions

3.5.14 Group 3.12: PID-controller 1

3.5.14.1 Basic settings

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.12.1.1	PID gain	0.00	1000.00	%	100.00	118	If the value of the parameter is set to 100% a change of 10% in the error value causes the controller output to change by 10%.
M3.12.1.2	PID integration time	0.00	600.00	s	1.00	119	If this parameter is set to 1,00 second a change of 10% in the error value causes the controller output to change by 10.00%/s.
M3.12.1.3	PID derivation time	0.00	100.00	s	0.00	132	If this parameter is set to 1,00 second a change of 10% in the error value during 1.00 s causes the controller output to change by 10.00%.
M3.12.1.4	Process unit selection	1	40		1	1036	Select unit for actual value.
M3.12.1.5	Process unit min	Varies	Varies	Varies	0	1033	
M3.12.1.6	Process unit max	Varies	Varies	Varies	100	1034	
M3.12.1.7	Process unit decimals	0	4		2	1035	Number of decimals for process unit value
M3.12.1.8	Error inversion	0	1		0	340	0 = Normal (Feedback < Setpoint -> Increase PID output) 1 = Inverted (Feedback < Setpoint -> Decrease PID output)
M3.12.1.9	Dead band hysteresis	Varies	Varies	Varies	0	1056	Dead band area around the setpoint in process units.The PID output is locked if the feedback stays within the deadband area for a predefined time.
M3.12.1.10	Dead band delay	0.00	320.00	s	0.00	1057	If the feedback stays within the dead band area for a predefined time, the output is locked.

Table 39.

3.5.14.2 Setpoints

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.12.2.1	Keypad setpoint 1	Varies	Varies	Varies	0	167	
M3.12.2.2	Keypad setpoint 2	Varies	Varies	Varies	0	168	
M3.12.2.3	Setpoint ramp time	0.00	300.0	s	0.00	1068	Defines the rising and falling ramp times for setpoint changes. (Time to change from minimum to maximum)
M3.12.2.4	Setpoint source 1 selection	0	16		1	332	0 = Not used 1 = Keypad setpoint 1 2 = Keypad setpoint 2 3 = AI1 4 = AI2 5 = AI3 6 = AI4 7 = AI5 8 = AI6 9 = ProcessDataIn1 10 = ProcessDataIn2 11 = ProcessDataIn3 12 = ProcessDataIn4 13 = ProcessDataIn5 14 = ProcessDataIn6 15 = ProcessDataIn7 16 = ProcessDataIn8 AI's and ProcessDataIn are handled as percent (0.00-100.00%) and scaled according to Setpoint minimum and maximum. **NOTE:** ProcessDataIn use two decimals.
M3.12.2.5	Setpoint 1 minimum	-200.00	200.00	%	0.00	1069	Minimum value at analog signal minimum.
M3.12.2.6	Setpoint 1 maximum	-200.00	200.00	%	100.00	1070	Maximum value at analog signal maximum.
M3.12.2.7	Sleep frequency limit 1	0.00	320.00	Hz	0.00	1016	Drive goes to sleep mode when the output frequency stays below this limit for a time greater than that defined by parameter *Sleep delay*.
M3.12.2.8	Sleep delay 1	0	3000	s	0	1017	The minimum amount of time the frequency has to remain below the Sleep level before the drive is stopped.
M3.12.2.9	Wake-up level 1			Varies	0.0000	1018	Defines the level for the PID feedback value wake-up supervision. Uses selected process units.
M3.12.2.10	Setpoint 1 boost	-2.0	2.0	x	1.0	1071	The setpoint can be boosted with a digital input.
M3.12.2.11	Setpoint source 2 selection	0	16		2	431	See par. M3.12.2.4
M3.12.2.12	Setpoint 2 minimum	-200.00	200.00	%	0.00	1073	Minimum value at analog signal minimum.

M3.12.2.13	Setpoint 2 maximum	-200.00	200.00	%	100.00	1074	Maximum value at analog signal maximum.
M3.12.2.14	Sleep frequency limit 2	0.00	320.00	Hz	0.00	1075	See M3.12.2.7.
M3.12.2.15	Sleep delay 2	0	3000	s	0	1076	See M3.12.2.8.
M3.12.2.16	Wake-up level 2			Varies	0.0000	1077	See M3.12.2.9.
M3.12.2.17	Setpoint 2 boost	-2.0	2.0	x	1.0	1078	See M3.12.2.10.

Table 40.

3.5.14.3 Feedbacks

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.12.3.1	Feedback function	1	9		1	333	1=Only Source1 in use 2=SQRT(Source1);(Flow=Constant x SQRT(Pressure)) 3=SQRT(Source1- Source 2) 4=SQRT(Source 1) + SQRT (Source 2) 5=Source 1 + Source 2 6=Source 1 - Source 2 7=MIN (Source 1, Source 2) 8=MAX (Source 1, Source 2) 9=MEAN (Source1, Source2)
M3.12.3.2	Feedback function gain	-1000.0	1000.0	%	100.0	1058	Used e.g. with selection 2 in *Feedback function*
M3.12.3.3	Feedback 1 source selection	0	14		2	334	0 = Not used 1 = AI1 2 = AI2 3 = AI3 4 = AI4 5 = AI5 6 = AI6 7 = ProcessDataIn1 8 = ProcessDataIn2 9 = ProcessDataIn3 10 = ProcessDataIn4 11 = ProcessDataIn5 12 = ProcessDataIn6 13 = ProcessDataIn7 14 = ProcessDataIn8 AI's and ProcessDataIn are handled as % (0.00-100.00%) and scaled according to Feedback min and max. **NOTE:** ProcessDataIn use two decimals.
M3.12.3.4	Feedback 1 minimum	-200.00	200.00	%	0.00	336	Minimum value at analog signal minimum.
M3.12.3.5	Feedback 1 maximum	-200.00	200.00	%	100.00	337	Maximum value at analog signal maximum.
M3.12.3.6	Feedback 2 source selection	0	14		0	335	See M3.12.3.3
M3.12.3.7	Feedback 2 minimum	-200.00	200.00	%	0.00	338	Minimum value at analog signal minimum.
M3.12.3.8	Feedback 2 maximum	-200.00	200.00	%	100.00	339	Maximum value at analog signal maximum.

Table 41.

3.5.14.4 Feedforward

Feedforward usually needs accurate process models, but in some simple cases a gain + offset type of feedforward is enough. The feedforward part does not use any feedback measurements of the actual controlled process value (water level in the example on page 77). Feedforward control uses other measurements which are indirectly affecting the controlled process value.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.12.4.1	Feedforward function	1	9		1	1059	See M3.12.3.1.
M3.12.4.2	Feedforward function gain	-1000	1000	%	100.0	1060	See M3.12.3.2
M3.12.4.3	Feedforward 1 source selection	0	14		0	1061	See M3.12.3.3
M3.12.4.4	Feedforward 1 minimum	-200.00	200.00	%	0.00	1062	See M3.12.3.4
M3.12.4.5	Feedforward 1 maximum	-200.00	200.00	%	100.00	1063	See M3.12.3.5
M3.12.4.6	Feedforward 2 source selection	0	14		0	1064	See M3.12.3.6
M3.12.4.7	Feedforward 2 min	-200.00	200.00	%	0.00	1065	See M3.12.3.7
M3.12.4.8	Feedforward 2 max	-200.00	200.00	%	100.00	1066	See M3.12.3.8

Table 42.

3.5.14.5 Process supervision

Process supervision is used to control that the actual value stays within predefined limits. With this function you can e.g. detect a major pipe burst and stop unnecessary flooding. See more on page 78.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.12.5.1	Enable process supervision	0	1		0	735	0 = Disabled 1 = Enabled
M3.12.5.2	Upper limit	Varies	Varies	Varies	Varies	736	Upper actual/process value supervision
M3.12.5.3	Lower limit	Varies	Varies	Varies	Varies	758	Lower actual/process value supervision
M3.12.5.4	Delay	0	30000	s	0	737	If the desired value is not reached within this time a fault or alarm is created.

Table 43.

3.5.14.6 Pressure loss compensation

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.12.6.1	Enable setpoint 1	0	1		0	1189	Enables pressure loss compensation for setpoint 1. 0 = Disabled 1 = Enabled
M3.12.6.2	Setpoint 1 max compensation	Varies	Varies	Varies	Varies	1190	Value added proportionally to the frequency. Setpoint compensation = Max compensation * (FreqOut-MinFreq)/(Max-Freq-MinFreq)
M3.12.6.3	Enable setpoint 2	0	1		0	1191	See M3.12.6.1.
M3.12.6.4	Setpoint 2 max compensation	Varies	Varies	Varies	Varies	1192	See M3.12.6.2.

Table 44.

3.5.14.7 PID1 Soft Fill

The Soft Fill function is used, for example, to avoid pressure pikes, the so-called "water hammers" in pipes when the drive starts to regulate. If not controlled, these pikes might lead to damaged pipes. See more information on page 81.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.12.7.1	Enable soft fill	0	1		0	1094	0=Disable 1=Enable
M3.12.7.2	Soft fill frequency	M3.3.1	M3.3.2	Hz	0.00	1055	The drive accelerates to this frequency before starting to control.
M3.12.7.3	Soft fill level	0	Varies	Varies	0.0000	1095	The drive runs at the Soft Fill frequency until the feedback reaches this value. When reached, the controller starts to regulate.
M3.12.7.4	Soft fill timeout	0	30000	s	0	1096	If the desired value is not reached within this time, fault or alarm is triggered (leaking pipe alarm). 0=No timeout used

Table 45. PID1 Soft fill parameters

3.5.15 Group 3.13: PID-controller 2

3.5.15.1 Basic settings

For more detailed information, see chapter 3.5.14.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.13.1.1	Enable PID	0	1		0	1630	0 = Disabled 1 = Enabled
M3.13.1.2	Output in Stop	0.0	100.0	%	0.0	1100	The output value of the PID controller in % of its maximum output value while it is stopped from digital input
M3.13.1.3	PID gain	0.00	1000.00	%	100.00	1631	
M3.13.1.4	PID integration time	0.00	600.00	s	1.00	1632	
M3.13.1.5	PID derivation time	0.00	100.00	s	0.00	1633	
M3.13.1.6	Process unit selection	0	40		1	1635	
M3.13.1.7	Process unit min	Varies	Varies	Varies	0	1664	
M3.13.1.8	Process unit max	Varies	Varies	Varies	100	1665	
M3.13.1.9	Process unit decimals	0	4		2	1666	
M3.13.1.10	Error inversion	0	1		0	1636	
M3.13.1.11	Dead band hysteresis	Varies	Varies	Varies	0.0	1637	
M3.13.1.12	Dead band delay	0.00	320.00	s	0.00	1638	

Table 46.

3.5.15.2 Setpoints

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.13.2.1	Keypad setpoint 1	0.00	100.00	Varies	0.00	1640	
M3.13.2.2	Keypad setpoint 2	0.00	100.00	Varies	0.00	1641	
M3.13.2.3	Setpoint ramp time	0.00	300.00	s	0.00	1642	
M3.13.2.4	Setpoint source 1 selection	0	16		1	1643	
M3.13.2.5	Setpoint 1 minimum	-200.00	200.00	%	0.00	1644	Minimum value at analog signal minimum.
M3.13.2.6	Setpoint 1 maximum	-200.00	200.00	%	100.00	1645	Maximum value at analog signal maximum.
M3.13.2.7	Setpoint source 2 selection	0	16		0	1646	See M3.13.2.4.
M3.13.2.8	Setpoint 2 minimum	-200.00	200.00	%	0.00	1647	Minimum value at analog signal minimum.
M3.13.2.9	Setpoint 2 maximum	-200.00	200.00	%	100.00	1648	Maximum value at analog signal maximum.

Table 47.

3.5.15.3 Feedback

For more detailed information, see chapter 3.5.14.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.13.3.1	Feedback function	1	9		1	1650	
M3.13.3.2	Feedback function gain	-1000.0	1000.0	%	100.0	1651	
M3.13.3.3	Feedback 1 source selection	0	14		1	1652	
M3.13.3.4	Feedback 1 minimum	-200.00	200.00	%	0.00	1653	Minimum value at analog signal minimum.
M3.13.3.5	Feedback 1 maximum	-200.00	200.00	%	100.00	1654	Maximum value at analog signal maximum.
M3.13.3.6	Feedback 2 source selection	0	14		2	1655	
M3.13.3.7	Feedback 2 minimum	-200.00	200.00	%	0.00	1656	Minimum value at analog signal minimum.
M3.13.3.8	Feedback 2 maximum	-200.00	200.00	%	100.00	1657	Maximum value at analog signal maximum.

Table 48.

3.5.15.4 Process supervision

For more detailed information, see chapter 3.5.14.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.13.4.1	Enable supervision	0	1		0	1659	0 = Disabled 1 = Enabled
M3.13.4.2	Upper limit	Varies	Varies	Varies	Varies	1660	
M3.13.4.3	Lower limit	Varies	Varies	Varies	Varies	1661	
M3.13.4.4	Delay	0	30000	s	0	1662	If the desired value is not reached within this time a fault or alarm is activated.

Table 49.

3.5.16 Group 3.14: Pump and Fan Cascade

The *Multi-pump* functionality allows you to control **up to 4 motors** (pumps, fans) with PID controller 1. The drive is connected to one motor which is the "regulating" motor connecting and disconnecting the other motors to/from the mains, by means of contactors controlled with relays when needed in order to maintain the right setpoint. The *Autochange* function controls the order/priority in which the motors are started in order to guarantee their equal wear. The controlling motor **can be included** in the autochange and interlocks logic, or, it may be selected to always functions as Motor 1. Motors can be taken out of use momentarily, e.g. for service, using the motor *Interlock function*. See page 82.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.14.1	Number of motors	1	4		1	1001	Total number of motors (pumps/fans) used in multi-pump system
M3.14.2	Interlock function	0	1		1	1032	Enable/Disable use of interlocks. Interlocks are used to tell the system if a motor is connected or not. 0 = Disabled 1 = Enabled
M3.14.3	Include FC	0	1		1	1028	Include the drive in the autochange and interlocking system. 0 = Disabled 1 = Enabled
M3.14.4	Autochange	0	1		0	1027	Disable/enable rotation of starting order and priority of motors. 0 = Disabled 1 = Enabled
M3.14.5	Autochange interval	0.0	3000.0	h	48.0	1029	After the expiry of the time defined with this parameter, the autochange function takes place if the capacity used lies below the level defined with parameters M3.14.6 and M3.14.7.
M3.14.6	Autochange: Frequency limit	0.00	50.00	Hz	25.00	1031	These parameters define the level below which the capacity used must remain so that the autochange can take place.
M3.14.7	Autochange: Motor limit	0	4		1	1030	
M3.14.8	Bandwidth	0	100	%	10	1097	Percentage of the setpoint. E.g.: Setpoint = 5 bar, Bandwidth = 10%: As long as the feedback value stays within 4.5...5.5 bar motor disconnection or removal will not take place.
M3.14.9	Bandwidth delay	0	3600	s	10	1098	With feedback outside the bandwidth, this time must pass before pumps are added or removed.

Table 50. Multi-pump parameters

3.5.17 Group 3.15: Maintenance counters

Three maintenance counters can be programmed and given alarm and fault levels independently. The alarm or fault level, or both, can be used.

There are two modes (hours or revolutions). Revolutions are estimated by integrating the Motor Speed every second and shown in 1000 revolutions on the keypad.

When one of the limits is reached a warning or a fault is triggered and shown on the panel. It is also possible to send information to a relay that a warning or fault limit has been reached. Timers are also independently resettable with the reset parameter or a digital input.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.15.1	Counter 1 mode	0	2		0	1104	0 = Not used 1 = Hours 2 = Revs*1000
M3.15.2	Counter 1 alarm limit	0	80000	h/revs	0	1105	Defines when to trig a maintenance alarm for Counter 1. 0 = Not used
M3.15.3	Counter 1 fault limit	0	80000	h/revs	0	1106	Defines when to trig a maintenance fault for Counter 1. 0 = Not used
M3.15.4	Counter 1 reset	0	1		0	1107	Changing parameter value from 0 to 1 resets counter.
M3.15.5	Counter 2 mode	0	2		0	1108	0 = Not used 1 = Hours 2 = Revs*1000
M3.15.6	Counter 2 alarm limit	0	80000	h/revs	0	1109	Defines when to trig a maintenance alarm for Counter 2. 0 = Not used
M3.15.7	Counter 2 fault limit	0	80000	h/revs	0	1110	Defines when to trig a maintenance fault for Counter 2. 0 = Not used
M3.15.8	Counter 2 reset	0	1		0	1111	Changing parameter value from 0 to 1 resets counter.
M3.15.9	Counter 3 mode	0	2		0	1163	0 = Not used 1 = Hours 2 = Revs*1000
M3.15.10	Counter 3 alarm limit	0	80000	h/revs	0	1164	Defines when to trig a maintenance alarm for Counter 3. 0 = Not used
M3.15.11	Counter 3 fault limit	0	80000	h/revs	0	1165	Defines when to trig a maintenance fault for Counter 3. 0 = Not used
M3.15.12	Counter 3 reset	0	1		0	1166	Changing parameter value from 0 to 1 resets counter.

Table 51. Maintenance counter parameters

3.5.18 Group 3.16: Fire mode

Drive ignores all commands from keypad, fieldbuses and PC tool and runs at preset frequency when activated. If activated, alarm sign is shown on the keypad and **warranty is void**. In order to enable the function, you need to set a password in the description field for parameter *Fire Mode password*.

NOTE! THE WARRANTY IS VOID IF THIS FUNCTION IS ACTIVATED! There is also a different password for test mode to be used for testing the Fire Mode without the warranty becoming void.

Code	Parameter	Min	Max	Unit	Default	ID	Description
M3.16.1	Fire Mode password	0	9999		0	1599	1001 = Enabled 1234 = Test mode
M3.16.2	Fire Mode activation				DigIN Slot0.2	1596	FALSE = Fire Mode active TRUE = No action
M3.16.3	Fire Mode frequency	0	M3.3.2	Hz	0.00	1598	Frequency used when Fire Mode is activated.
M3.16.4	Fire Mode status	0	3		0	1597	Monitoring value (see also Table 14) 0=Disabled 1=Enabled 2=Activated (Enabled + DI Open) 3=Test Mode

Table 52. Fire mode parameters

3.6 HVAC Application - Additional parameter information

Due to its user-friendliness and simplicity of use, the most parameters of the HVAC Application only require a basic description which is given in the parameter tables in chapter 3.5.

In this chapter, you will find additional information on certain most advanced parameters of the HVAC Application. Should you not find the information you need contact your distributor.

M3.1.1.7 MOTOR CURRENT LIMIT

This parameter determines the maximum motor current from the drive. The parameter value range differs from size to size.

When the current limit is active the drive output frequency is decreased.

NOTE: This is not an overcurrent trip limit.

M3.2.5 STOP FUNCTION

Selection number	Selection name	Description
0	Coasting	The motor is allowed to stop on its own inertia. The control by the drive is discontinued and the drive current drops to zero as soon as the stop command is given.
1	Ramp	After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters to zero speed.

M3.2.6 I/O A START/STOP LOGIC

Values 0...2 offer possibilities to control the starting and stopping of the drive with digital signal connected to digital inputs. CS = Control signal.

Selection number	Selection name	Note
0	Start forward	The functions take place when the contacts are closed.
1	CS1: Start fwd pulse CS2: Stop pulse	For 3-wire control (pulse control) See Figure 8.
2	Start fwd pulse	Required to start.
3	AI1 threshold	The motor will start at the level set with parameter this parameter and stop at the same -2% AI1 can also be used as frequency reference in parallel.

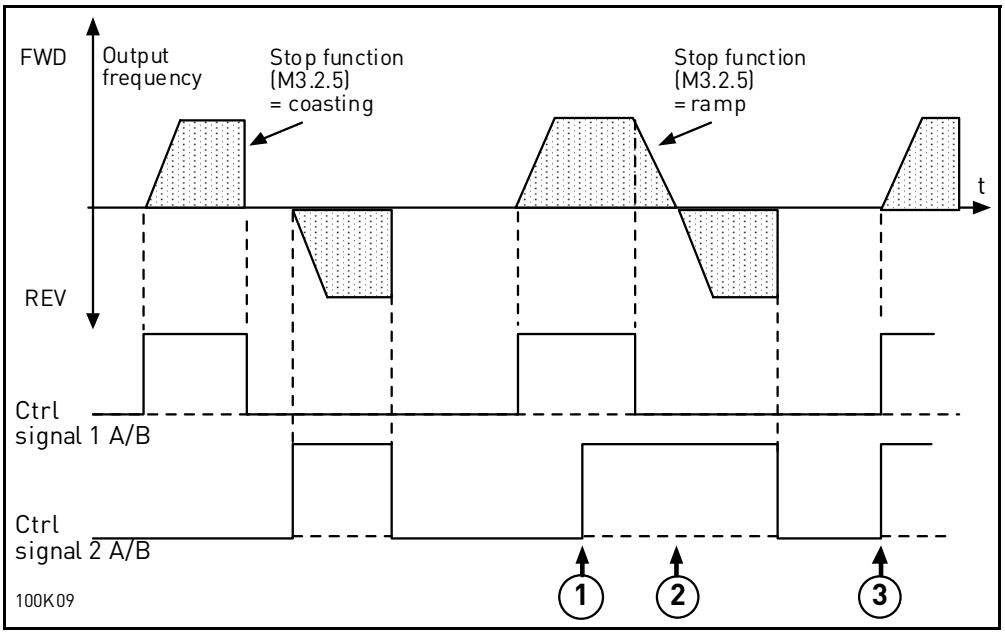


Figure 7. Start forward

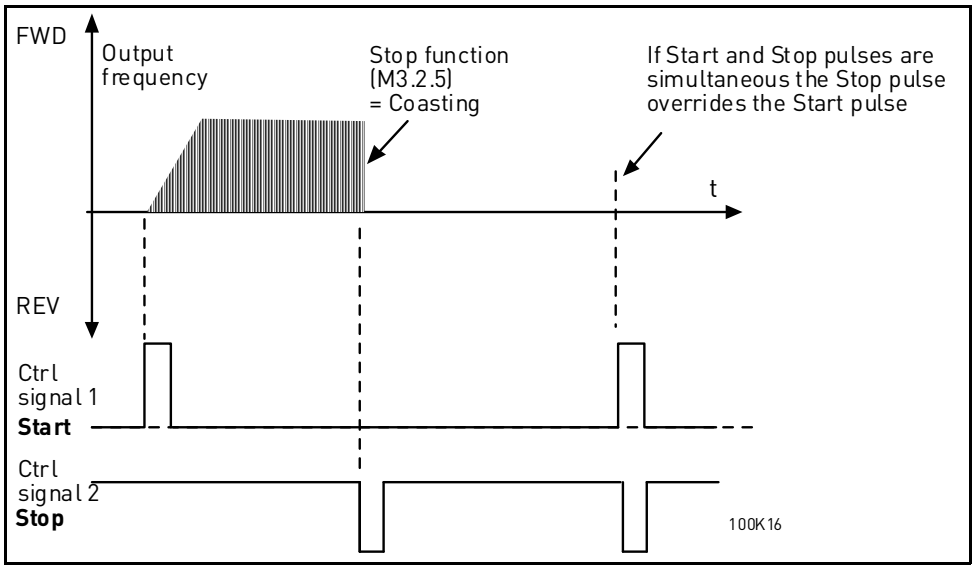


Figure 8. Start pulse/ Stop pulse

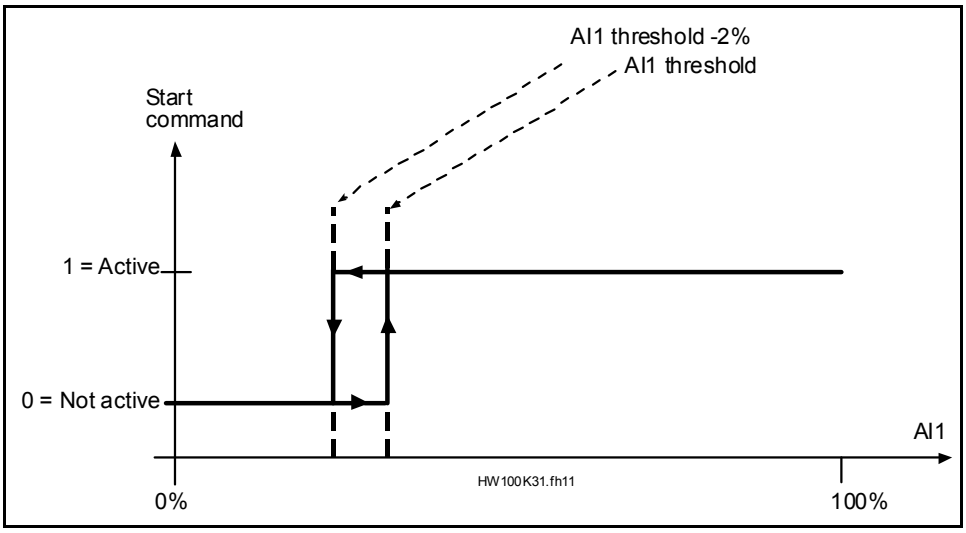


Figure 9. AI1 threshold

M3.2.10 KEYPAD MASTER STOP

The AC drive can be forced to stop state from keypad stop button even if it is controlled from another control place (*Remote*). If this measure is taken, the drive goes to the alarm state and cannot be restarted from the remote control place before the start button has been pressed (while in *Remote*).

You can still momentarily switch to *Local* and start there but when going back to *Remote* a start button press is needed. This also applies after a power-down as the state of this function is retained in memory.

The function can be enabled or disabled with this parameter.

M3.3.10 PRESET FREQUENCY MODE

You can use the preset frequency parameters to define certain frequency references in advance. These references are then applied by activating/inactivating digital inputs connected to parameters M3.5.1.16, M3.5.1.17 and M3.5.1.18 ((*Preset frequency selection 0, Preset frequency selection 1* and *Preset frequency selection 2*). Two different logics can be selected:

Selection number	Selection name	Note
0	Binary coded	Combine activated inputs according to Table 53 to choose the Preset frequency needed.
1	Number (of inputs used)	According to how many of the inputs assigned for *Preset frequency selections* are active you can apply the *Preset frequencies* 1 to 3.

M3.3.11 TO M3.3.18 PRESET FREQUENCIES 1 TO 7

The values of the preset frequencies are automatically limited between the minimum and maximum frequencies (M3.3.1 and M3.3.2). See table below.

Required action			Activated frequency
Choose value 1 for parameter M3.3.3			Preset frequency 0
B2	B1	B0	Preset frequency 1
B2	B1	B0	Preset frequency 2
B2	B1	B0	Preset frequency 3
B2	B1	B0	Preset frequency 4
B2	B1	B0	Preset frequency 5
B2	B1	B0	Preset frequency 6
B2	B1	B0	Preset frequency 7

Table 53. Selection of preset frequencies; ■ = input activated

M3.4.1 RAMP 1 SHAPE

The start and end of acceleration and deceleration ramps can be smoothed with this parameter. Setting value 0 gives a linear ramp shape which causes acceleration and deceleration to act immediately to the changes in the reference signal.

Setting value 0.1…10 seconds for this parameter produces an S-shaped acceleration/deceleration. The acceleration time is determined with parameters M3.4.2 and M3.4.3. See Figure 10.

These parameters are used to reduce mechanical erosion and current spikes when the reference is changed.

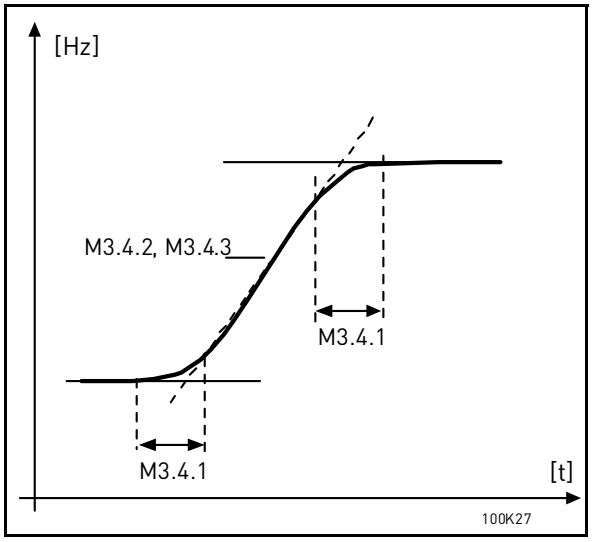


Figure 10.Acceleration/Deceleration (S-shaped)

M3.4.8 RAMP TIME OPTIMIZER

If the ramp time optimizer is enabled the deceleration time will be increased by the percentage defined in parameter M3.4.9 *Ramp optimizing percentage* every time we hit the overvoltage controller during deceleration or acceleration time when hitting the current limit during acceleration. There is also a parameter for setting a max limit for the ramp (M3.4.10). The ramp optimizer will not stretch the ramps above this limit.

NOTE: The ramp time optimizer only affects the settings of Ramp 1. Ramp 2 will not be modified.

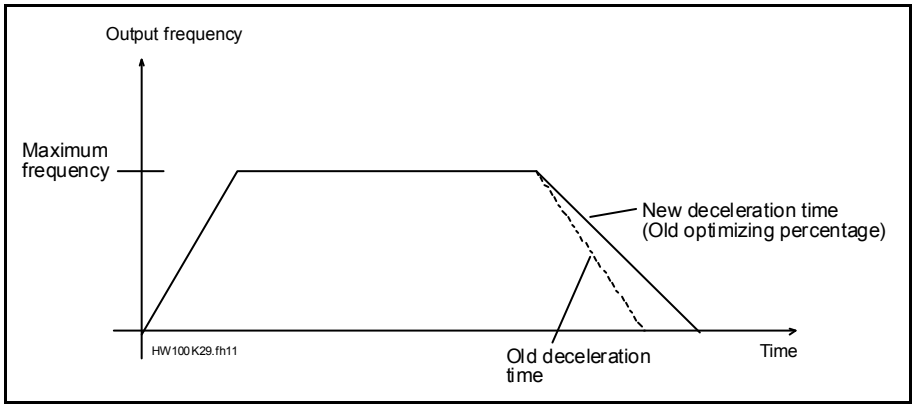


Figure 11.

M3.4.16 FLUX BRAKING

Instead of DC braking, flux braking is a useful way to raise the braking capacity in cases where additional brake resistors are not needed.

When braking is needed, the frequency is reduced and the flux in the motor is increased, which in turn increases the motor's capability to brake. Unlike DC braking, the motor speed remains controlled during braking.

The flux braking can be set ON or OFF.

NOTE: Flux braking converts the energy into heat at the motor, and should be used intermittently to avoid motor damage.

M3.5.1.10 RUN ENABLE

Contact open: Start of motor **disabled**
Contact closed: Start of motor **enabled**

The drive is stopped according to the selected function at M3.2.5. The follower drive will always coast to stop.

M3.5.1.11 RUN INTERLOCK 1
M3.5.1.12 RUN INTERLOCK 2

The drive cannot be started if any of the interlocks are open.

The function could be used for a damper interlock, preventing the drive to start with damper closed.

M3.5.1.16 PRESET FREQUENCY SELECTION 0
M3.5.1.17 PRESET FREQUENCY SELECTION 1
M3.5.1.18 PRESET FREQUENCY SELECTION 2

Connect a digital input to these functions with the programming method presented in chapter 3.5.2) to be able to apply Preset frequencies 1 to 7 (see Table 53 and pages 37, 40 and 68).

M3.5.2.2 AI1 SIGNAL FILTER TIME

When this parameter is given a value greater than 0 the function that filters out disturbances from the incoming analog signal is activated.

NOTE: Long filtering time makes the regulation response slower!

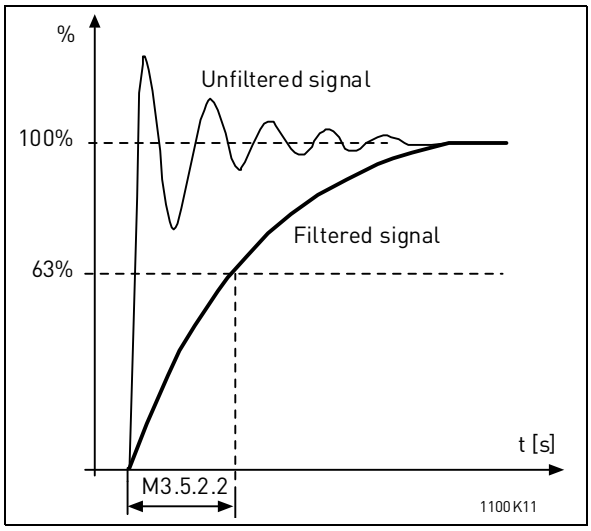


Figure 12. AI1 signal filtering

M3.5.3.2.1 BASIC RO1 FUNCTION

Selection	Selection name	Description
0	Not used	
1	Ready	The drive is ready to operate
2	Run	The drive operates (motor is running)
3	General fault	A fault trip has occurred
4	General fault inverted	A fault trip has **not** occurred
5	General alarm	
6	Reversed	The reverse command has been selected
7	At speed	The output frequency has reached the set reference
8	Motor regulator activated	One of the limit regulators (e.g. current limit, torque limit) is activated
9	Preset frequency active	The preset frequency has been selected with digital input
10	Keypad control active	Keypad control mode selected
11	I/O control B active	I/O control place B selected
12	Limit supervision 1	Activates if the signal value falls below or exceeds the set supervision limit (M3.8.3 or M3.8.7) depending on the selected function.
13	Limit supervision 2	
14	Start command active	Start command is active.
15	Reserved	
16	Fire mode ON	
17	RTC timer 1 control	Time channel 1 is used.

Selection	Selection name	Description
18	RTC timer 2 control	Time channel 2 is used.
19	RTC timer 3 control	Time channel 3 is used.
20	FB Control WordB.13	
21	FB Control WordB.14	
22	FB Control WordB.15	
23	PID1 in Sleep mode	
24	Reserved	
25	PID1 supervision limits	PID1 feedback value is beyond supervision limits.
26	PID2 supervision limits	PID2 feedback value is beyond supervision limits.
27	Motor 1 control	Contactor control for *Multi-pump* function
28	Motor 2 control	Contactor control for *Multi-pump* function
29	Motor 3 control	Contactor control for *Multi-pump* function
30	Motor 4 control	Contactor control for *Multi-pump* function
31	Reserved	(Always open)
32	Reserved	(Always open)
33	Reserved	(Always open)
34	Maintenance warning	
35	Maintenance fault	

Table 54. Output signals via RO1

M3.7.8 RESONANCE SWEEP ACC/DEC TIME

The anti-resonance function slowly sweeps through frequencies from MinFreq to MaxFreq and back to MinFreq with the ramp times set with this parameter. During this sweep, the user should press the OK-button every time passing a resonance range in order to tag where the range starts and ends.

If everything is fine the Prohibit frequency range parameters (in Prohibited Frequencies menu) are provided with right information. If there is a different amount of tags during ramp-up compared to ramp-down nothing will be done but an info message is shown. The same will happen if the bands are not reasonable.

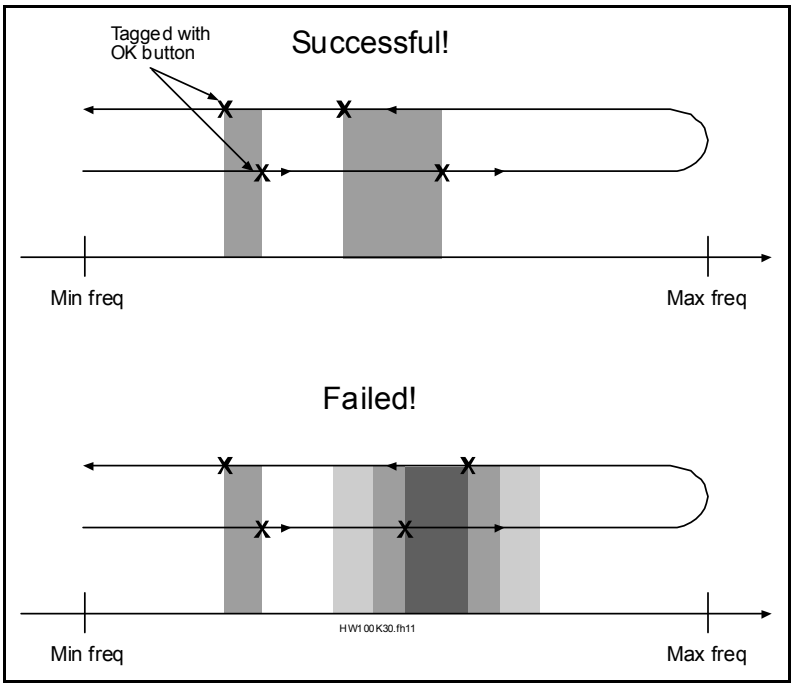


Figure 13.

M3.9.2 RESPONSE TO EXTERNAL FAULT

An alarm message or a fault action and message is generated by an external fault external fault signal in one of the programmable digital inputs (DI3 by default) using parameters M3.5.1.7 and M3.5.1.8. The information can also be programmed into any of the relay outputs.

M3.9.8 MOTOR THERMAL ZERO SPEED COOLING

Defines the cooling factor at zero speed in relation to the point where the motor is running at nominal speed without external cooling.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or even higher).

If you change the parameter M3.1.1.4 *(Motor nominal current)*, this parameter is automatically restored to the default value.

Setting this parameter does not affect the maximum output current of the drive which is determined by parameter M3.1.1.7 alone.

The corner frequency for the thermal protection is 70% of the motor nominal frequency (M3.1.1.2).

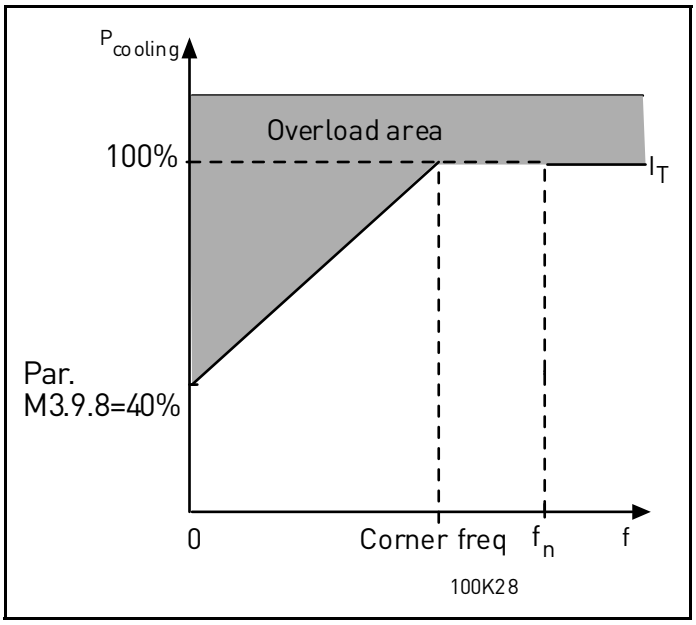


Figure 14. Motor thermal current I_T curve

M3.9.9 MOTOR THERMAL TIME CONSTANT

This is the thermal time constant of the motor. The bigger the motor, the bigger the time constant. The time constant is the time within which the calculated thermal stage has reached 63% of its final value.

The motor thermal time is specific to the motor design and it varies between different motor manufacturers. The default value of the parameter varies from size to size.

If the motor's t6-time (t6 is the time in seconds the motor can safely operate at six times the rated current) is known (given by the motor manufacturer) the time constant parameter can be set basing on it. As a rule of thumb, the motor thermal time constant in minutes equals to 2*t6. If the drive is in stop stage the time constant is internally increased to three times the set parameter value. The cooling in stop stage is based on convection and the time constant is increased.

See Figure 15.

M3.9.10 MOTOR THERMAL LOADABILITY FACTOR

Setting value to 130% means that the nominal temperature will be reached with 130% of motor nominal current.

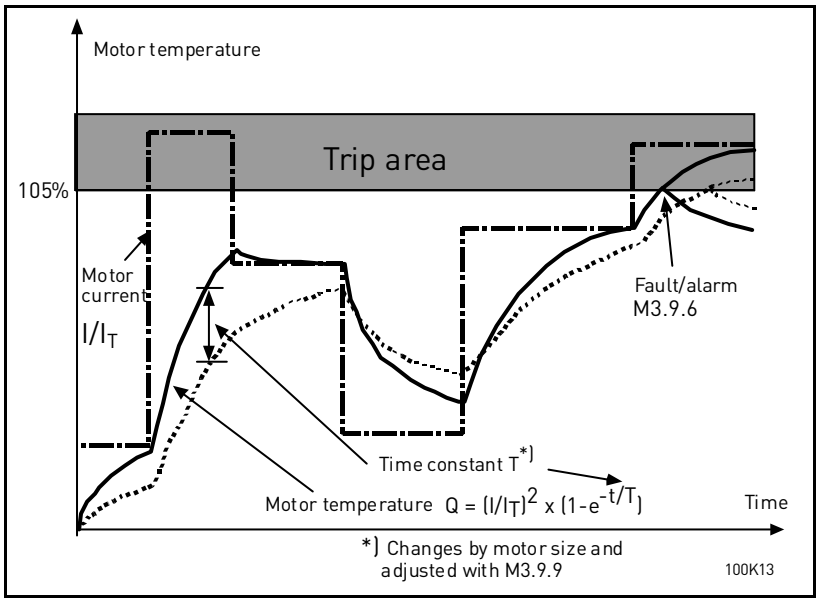


Figure 15. Motor temperature calculation

M3.10.1 AUTOMATIC RESET

Activate the *Automatic reset* after fault with this parameter.

NOTE: Automatic reset is allowed for certain faults only. By giving the parameters M3.10.6 to M3.10.13 the value **0** or **1** you can either allow or deny the automatic reset after the respective faults.

M3.10.3 WAIT TIME
M3.10.4 AUTOMATIC RESET: TRIAL TIME
M3.10.5 NUMBER OF TRIALS

The Automatic reset function keeps resetting the faults appearing during the time set with this parameter. If the number of faults during the trial time exceed the value of parameter M3.10.5 a permanent fault is generated. Otherwise the fault is cleared after the trial time has elapsed and the next fault start the trial time count again.

Parameter M3.10.5 determines the maximum number of automatic fault reset attempts during the trial time set by this parameter. The time count starts from the first autoreset. The maximum number is independent of the fault type.

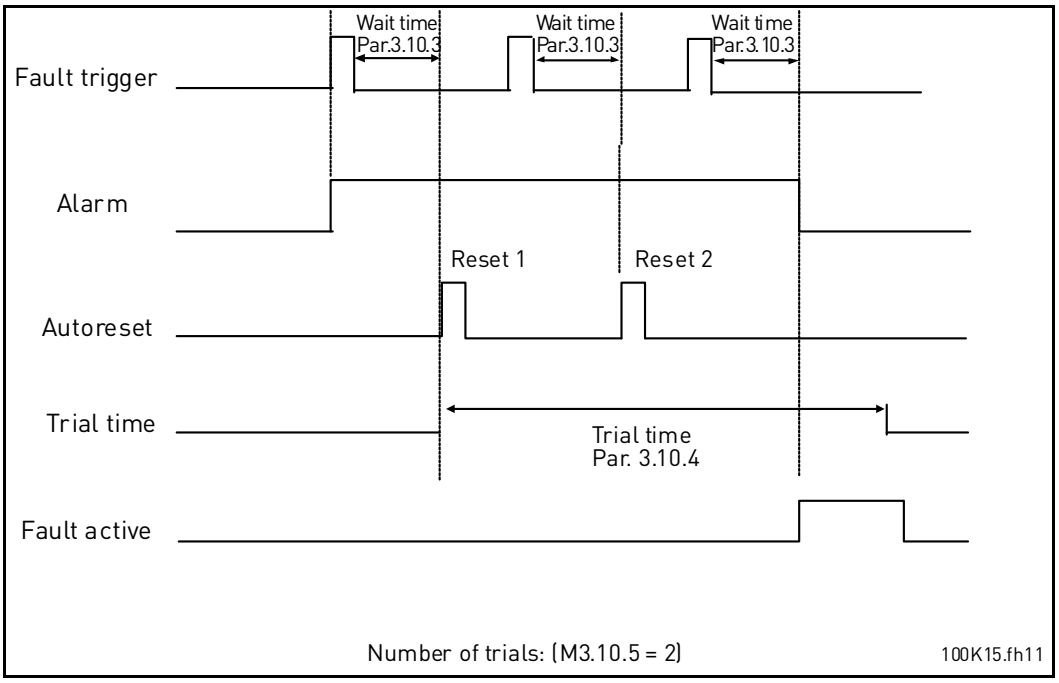


Figure 16. Automatic reset function

M3.12.1.9 DEAD BAND HYSTERESIS
M3.12.1.10 DEAD BAND DELAY

The PID controller output is locked if the actual value stays within the deadband area around the reference for a predefined time. This function will prevent unnecessary movement and wear on actuators, e.g. valves.

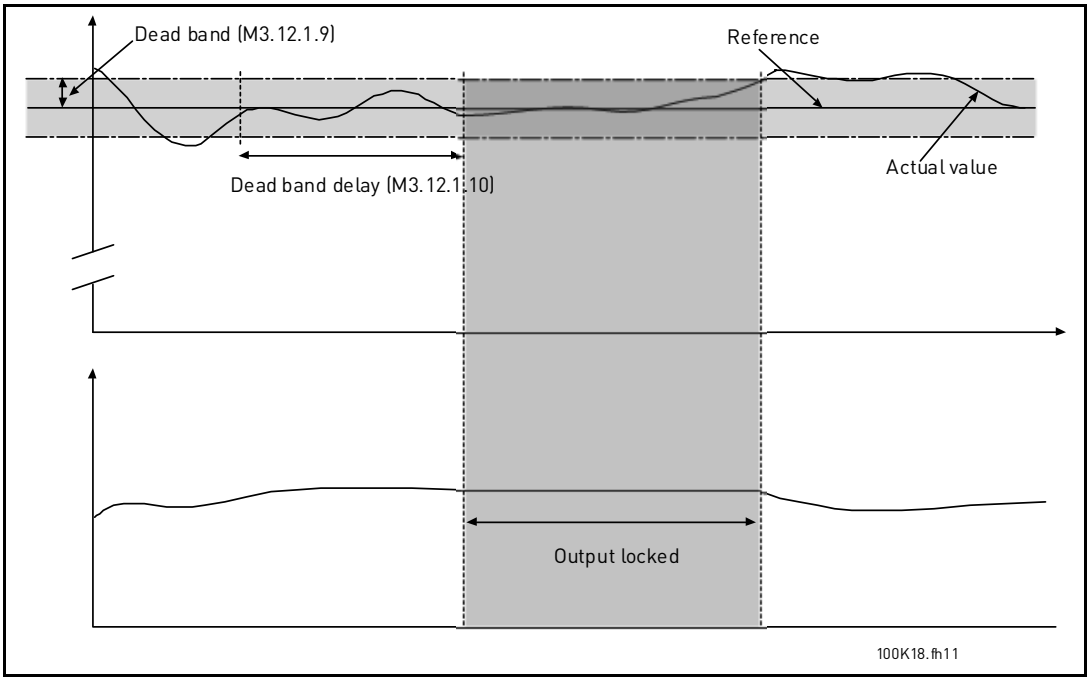


Figure 17. Dead band

M3.12.2.7 SLEEP FREQUENCY LIMIT 1
M3.12.2.8 SLEEP DELAY 1
M3.12.2.9 WAKE-UP LEVEL 1

This function will put the drive into sleep mode if the frequency stays below the sleep limit for a longer time than that set with the Sleep Delay (M3.12.2.8). This means that the start command remains on, but the run request is turned off. When the actual value goes below, or above, the wake-up level depending on the set acting mode the drive will activate the run request again if the start command is still on.

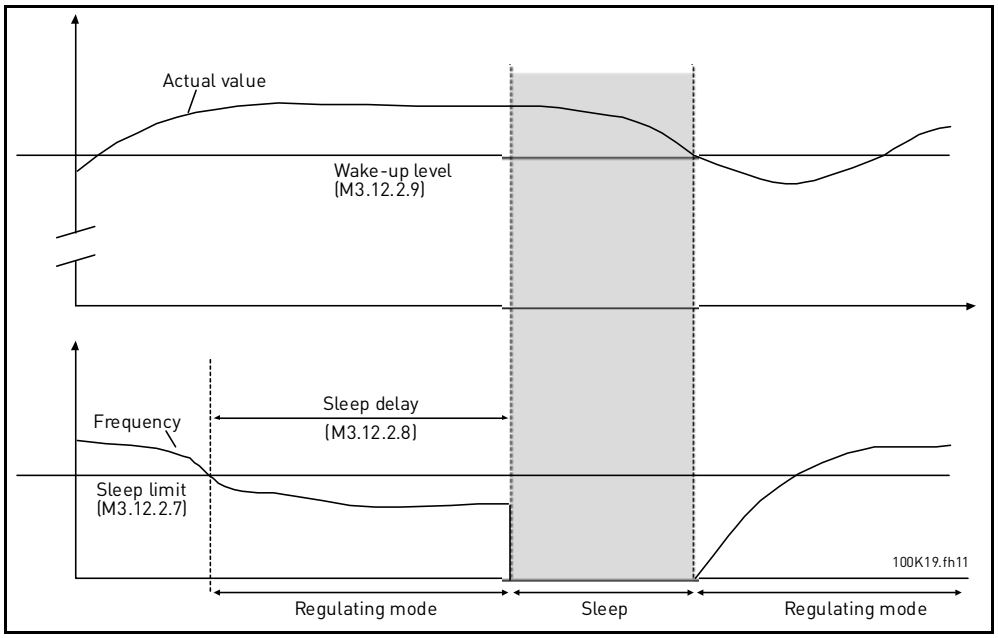


Figure 18. Sleep limit, Sleep delay, Wake-up level

M3.12.4.1 FEEDFORWARD FUNCTION

Feedforward usually needs accurate process models, but in some simple cases a gain + offset type of feedforward is enough. The feedforward part does not use any feedback measurements of the actual controlled process value (water level in the example on page 78). The feedforward control uses other measurements which are indirectly affecting the controlled process value.

Example 1:

Controlling the water level of a tank by means of flow control. The desired water level has been defined as a setpoint and the actual level as feedback. The control signal acts on the incoming flow.

The outflow could be thought of as a disturbance that can be measured. Based on the measurements of the disturbance, we can try to compensate for this disturbance by simple feedforward control (gain and offset) which is added to the PID output.

This way the controller would react much faster to changes in the outflow than if you just had measured the level.

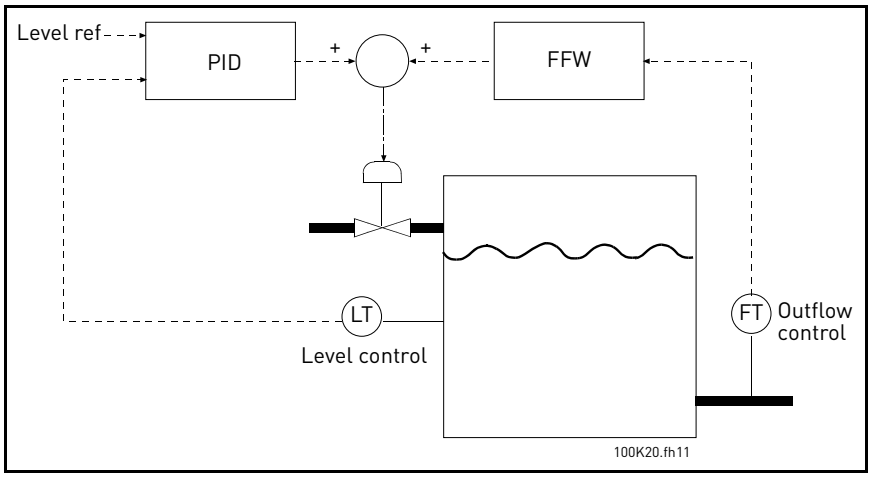


Figure 19. Feedforward control

M3.12.5.1 ENABLE PROCESS SUPERVISION

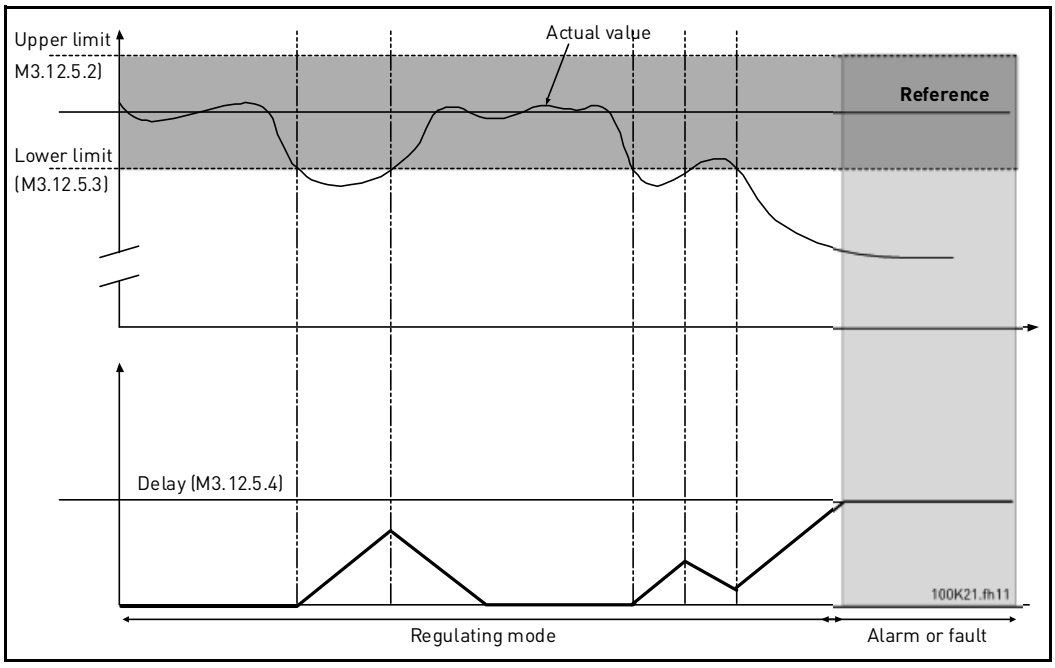


Figure 20. Process supervision

Upper and lower limits around the reference are set. When the actual value goes above or below these a counter starts counting up towards the Delay (M3.12.5.4). When the actual value is within the allowed area the same counter counts down instead. Whenever the counter is higher than the Delay an alarm or fault (depending on the selected response) is generated.

PRESSURE LOSS COMPENSATION

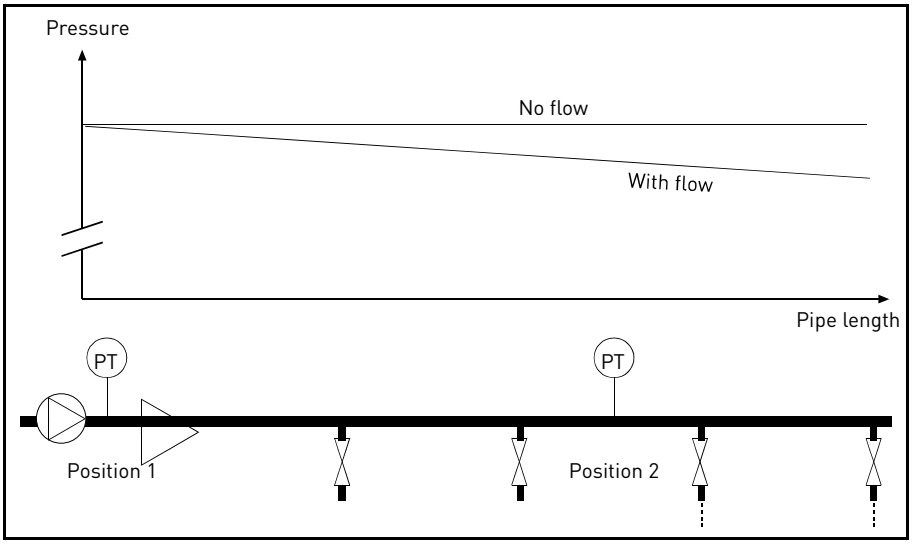


Figure 21. Position of pressure sensor

If pressurizing a long pipe with many outlets, the best place for the sensor would probably be halfway down the pipe (Position 2). However, sensors might, for example, be placed directly after the pump. This will give the right pressure directly after the pump, but farther down in the pipe the pressure will drop depending on the flow.

M3.12.6.1 ENABLE SETPOINT 1
M3.12.6.2 SETPOINT 1 MAX COMPENSATION

The sensor is placed in Position 1. The pressure in the pipe will remain constant when we have no flow. However, with flow, the pressure will drop farther down in the pipe. This can be compensated by raising the setpoint as the flow increases. In this case, the flow is estimated by the output frequency and the setpoint is linearly increased with the flow as in the figure below.

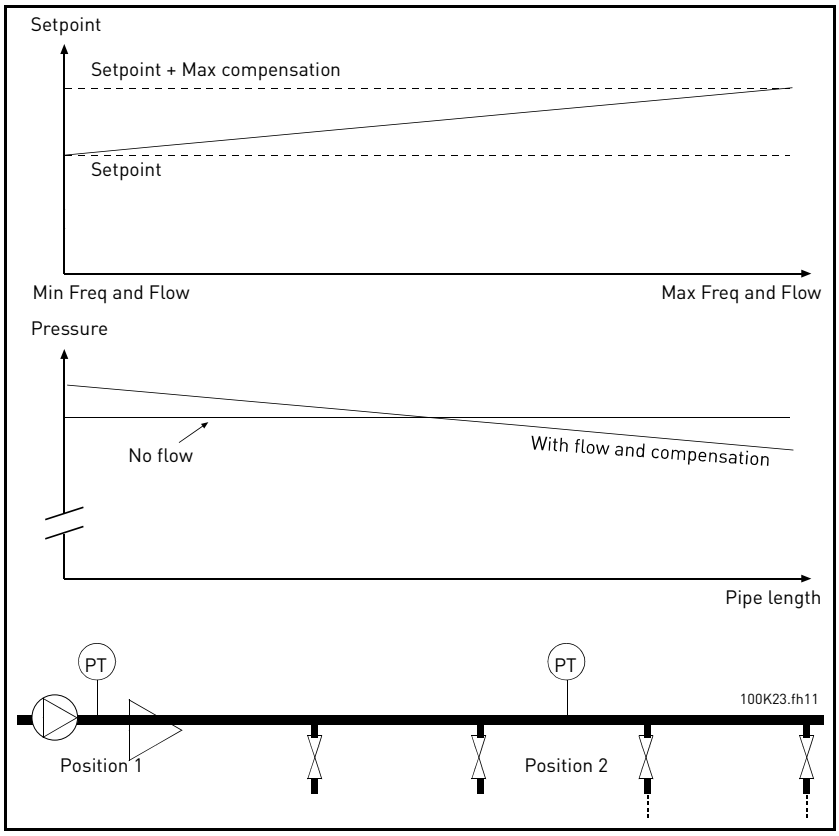


Figure 22. Enable setpoint 1 for pressure loss compensation

PUMP SOFT FILL FUNCTION

The Soft Fill function is used, for example, to avoid pressure pikes, the so-called "water hammers" in pipes when the drive starts to regulate. If not controlled, these pikes might lead to damaged pipes. See more information on page 81.

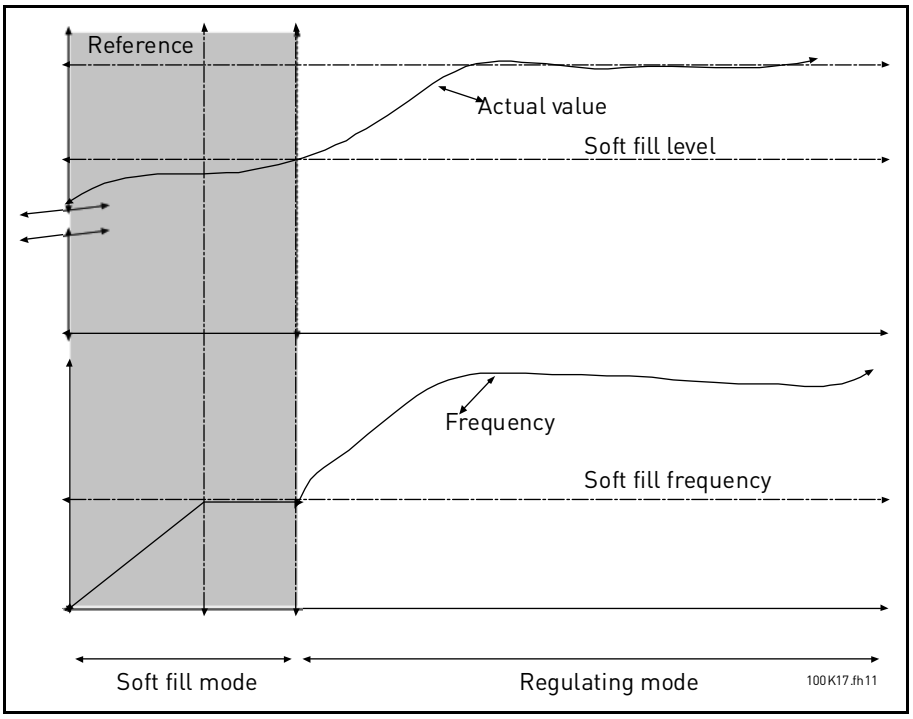


Figure 23.

The drive runs at the *Soft fill frequency* (M3.12.7.2) until the actual value reaches the *Soft fill level* (M3.12.7.3). After this the drive starts to regulate. If the *Soft fill level* isn't reached within the *Soft fill timeout* (M3.12.7.4) an alarm or fault is triggered according to the *Soft fill supervision* response (M3.9.16).

NOTE: The Soft fill function is disabled if parameter M3.12.1.8 *Error inversion* is set to *Inverted*.

MULTI-PUMP USE

A motor/motors are connected/disconnected if the PID controller is not able to keep the process value or feedback within the defined bandwith around the setpoint.

Criteria for connecting/adding motors (also see Figure 24):

- Feedback value outside the bandwidth area.
- Regulating motor running at a “close-to-max” frequency (-2Hz)
- Conditions above are fulfilled for a time longer than the bandwidth delay
- There are more motors available

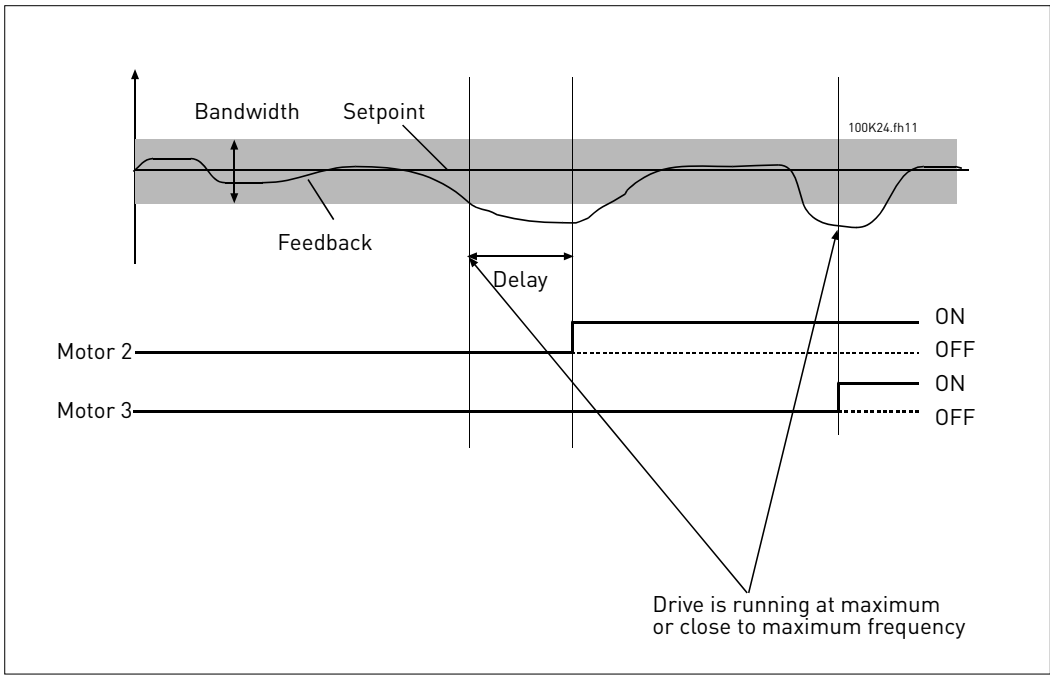


Figure 24.

Criteria for disconnecting/removing motors:

- Feedback value outside bandwidth area.
- Regulating motor running at a “close-to-min” frequency (+2 Hz)
- Conditions above are fulfilled for a time longer than the bandwidth delay
- There are more motors running than the regulating one.

M3.14.2 INTERLOCK FUNCTION

Interlocks can be used to tell the Multi Pump system that a motor is not available e.g. because of the motor is removed from the system for maintenance or bypassed for manual control.

Enable this function to use the interlocks. Choose the needed status for each motor by digital inputs (parameters M3.5.1.26 to M3.5.1.29). If the input is closed (TRUE) the motor is available for the Multi Pump system, otherwise it will not be connected by the Multi Pump logic.

EXAMPLE OF THE INTERLOCK LOGIC:

If the motor starting order is

1->**2**->**3**->**4**->**5**

Now, the interlock of motor **3** is removed, i.e. the value of parameter M3.5.1.27 is set to FALSE, the order changes to:

1->**2**->**4**->**5**.

If motor **3** is taken into use again (changing the value of parameter M3.5.1.27 to TRUE) the system runs on without stopping and motor **3** is placed last in the sequence:

1->**2**->**4**->**5**->**3**

As soon as the system is stopped or goes to sleep mode for the next time, the sequence is updated to its original order.

1->**2**->**3**->**4**->**5**

M3.14.3 INCLUDE FC

Selection	Selection name	Description
0	Disabled	Motor 1 (motor connected to drive) is always frequency controlled and not affected by interlocks.
1	Enabled	All motors can be controlled and are affected by interlocks.

WIRING

There are two different ways to make the connections depending on whether selection **0** or **1** is set as parameter value.

Selection 0, Disabled:

The drive or the regulating motor is not included in the autochange or interlocks logic. The drive is directly connected to motor 1 as in Figure 25 below. The other motors are auxiliary ones connected to the mains by contactors and controlled by relays in the drive.

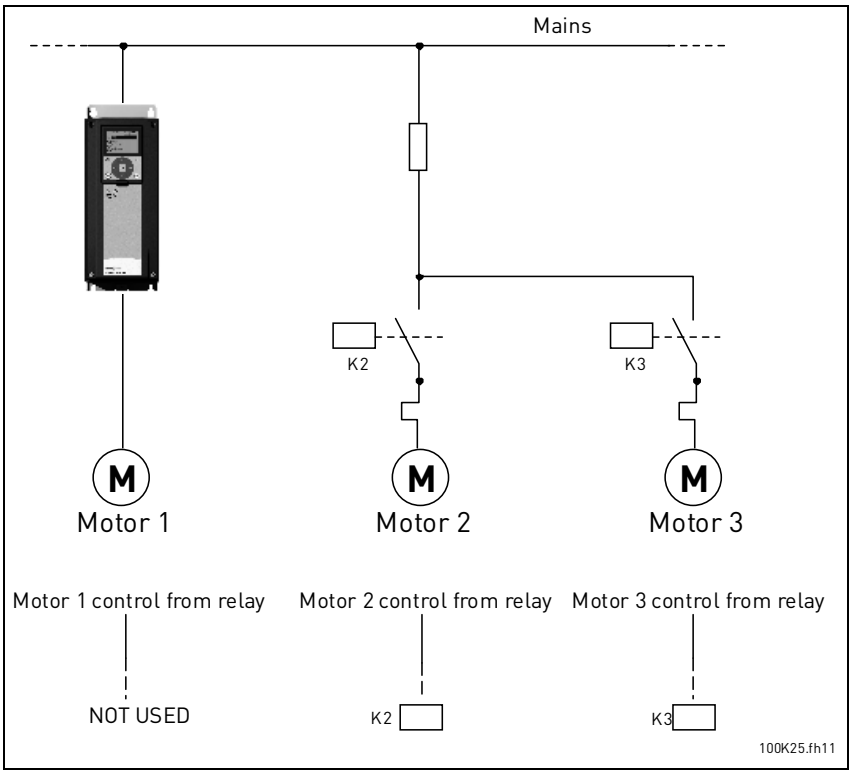


Figure 25.

Selection 1, Enabled:

If the regulating motor needs to be included in the autochange or interlock logic make the connection according to Figure 26 below.

Every motor is controlled with one relay but the contactor logic takes care that the first connected motor is always connected to the drive and next to the mains.

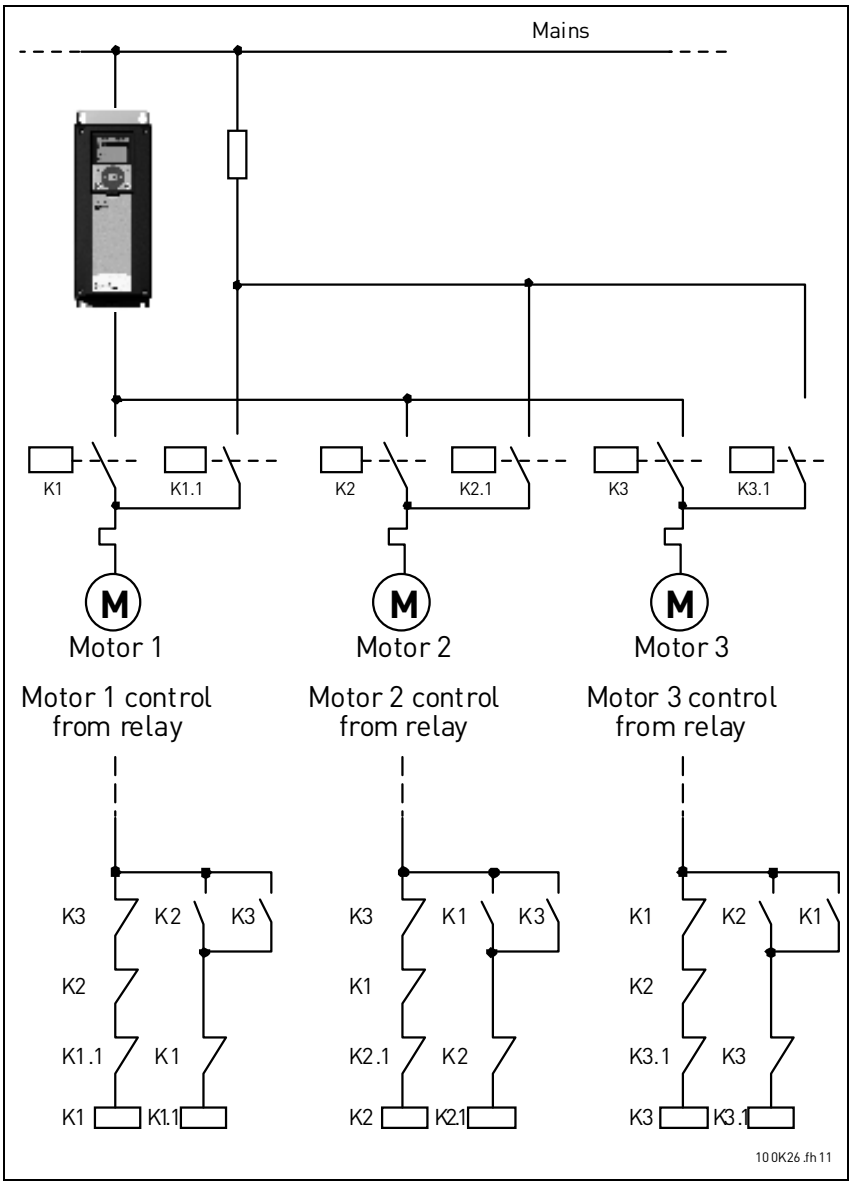

Mains
K1
K1.1
K2
K2.1
K3
K3.1
M
Motor 1
M
Motor 2
M
Motor 3
Motor 1 control from relay
Motor 2 control from relay
Motor 3 control from relay
K3
K2
K3
K2
K1.1
K1
K1
K1.1
K3
K1
K3
K1
K2.1
K2
K2
K2.1
K1
K2
K1
K2
K3.1
K3
K3
K3.1
100K26.fh11

Figure 26.

M3.14.4 AUTOCHANGE

Selection	Selection name	Description
0	Disabled	The priority/starting order of the motors is always 1-2-3-4-5 in normal operation. It might have changed during run if interlocks have been removed and added again, but the priority/order is always restored after a stop.
1	Enabled	The priority is changed at certain intervals to get an equal wear on all motors. The intervals of the auto-change can be changed (M3.14.5). You can also set a limit of how many motors are allowed to run (M3.14.7) as well as for the maximum frequency of the regulating drive when the autochange is done (M3.14.6). If the autochange interval M3.14.5) has expired, but the frequency and motor limits are not fulfilled, the autochange will be postponed until all conditions are met (this is to avoid e.g. sudden pressure drops because of the system performing an autochange when there is a high capacity demand at a pump station.

EXAMPLE:

In the autochange sequence after the autochange has taken place, the motor with the highest priority is placed last and the others are moved up by one place:

Starting order/priority of motors: **1**->**2**->**3**->**4**->**5**

--> *Autochange* -->

Starting order/priority of motors: **2**->**3**->**4**->**5**->**1**

--> *Autochange* -->

Starting order/priority of motors: **3**->**4**->**5**->**1**->**2**

3.7 HVAC Application - Fault tracing

When an unusual operating condition is detected by the drive control diagnostics, the drive initiates a notification visible, for example, on the keypad. The keypad will show the code, the name and a short description of the fault or alarm.

The notifications vary in consequence and required action. *Faults* make the drive stop and require reset of the drive. *Alarms* inform of unusual operating conditions but the drive will continue running. *Infos* may require resetting but do not affect the functioning of the drive.

For some faults you can program different responses in the application. See parameter group Protections.

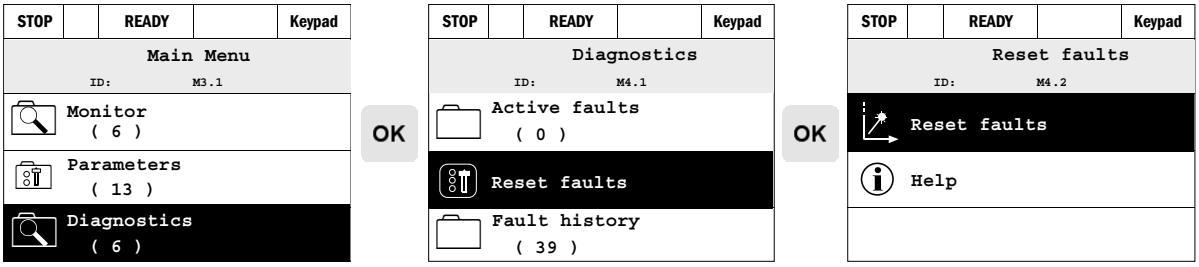
The fault can be reset with the *Reset button* on the control keypad or via the I/O terminal. The faults are stored in the Fault history menu which can be browsed. The different fault codes you will find in the table below.

NOTE: When contacting distributor or factory because of a fault condition, always write down all texts and codes on the keypad display.

3.7.1 Fault appears

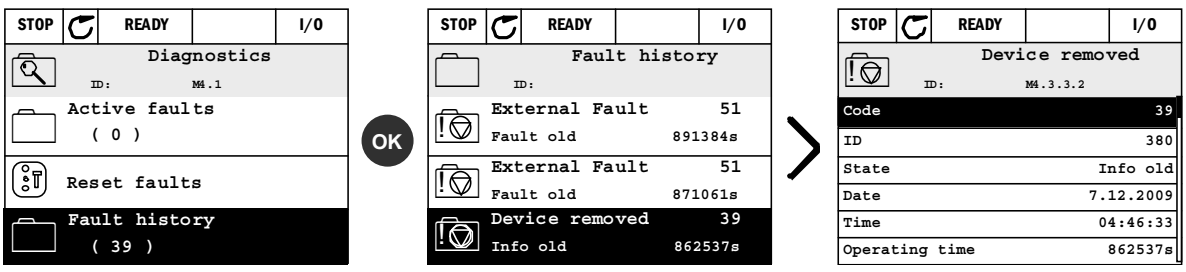
When a fault appears and the drive stops examine the cause of fault, perform the actions advised here and reset the fault either

1. with a long (1 s) press on the *Reset* button on the keypad or
2. by entering the *Diagnostics* Menu (M4), entering *Reset faults* (M4.2) and selecting *Reset faults* parameter.



3.7.2 Fault history

In menu M4.3 Fault history you find the maximum number of 40 occurred faults. On each fault in the memory you will also find additional information, see below.



3.7.3 Fault codes

Fault code	ID	Fault name	Possible cause	Remedy
1		Overcurrent	Drive has detected too high a current (>4*I_H) in the motor cable: • sudden heavy load increase • short circuit in motor cables • unsuitable motor Fault ID: 1 = Hardware fault 2 = Software fault	Check loading. Check motor. Check cables. Make identification run.
2		Overvoltage	The DC-link voltage has exceeded the limits defined. • too short a deceleration time • high overvoltage spikes in supply Fault ID: 10 = Hardware fault 11 = Software fault	Make deceleration time longer. Use brake chopper or brake resistor (available as options) Activate overvoltage controller. Check input voltage.
3		Earth fault	Current measurement has detected that the sum of motor phase current is not zero. • insulation failure in cables or motor Fault ID: 20 = Hardware fault 21 = Software fault	Check motor cables and motor.
5		Charging switch	The charging switch is open, when the START command has been given. • faulty operation • component failure Fault ID: 40 = Hardware fault	Reset the fault and restart. Should the fault re-occur, contact the distributor near to you.
7		Saturation	Various causes: • defective component • brake resistor short-circuit or overload Fault ID: 60 = Hardware fault	Cannot be reset from keypad. Switch off power. DO NOT RE-CONNECT POWER! Contact factory. If this fault appears simultaneously with Fault 1, check motor cables and motor
8		System fault	• Component failure • Faulty operation Fault ID: 600 = Communication between control board and power unit has failed 601 = Communication between control board and power unit has interference but is still working (ALARM) 602 = Watchdog has reset the CPU 603 = Voltage of auxiliary power in power unit is too low 604 = Phase fault: Voltage of an output phase does not follow the reference	Reset the fault and restart. Should the fault re-occur, contact the distributor near to you.

Fault code	ID	Fault name	Possible cause	Remedy
9		Undervoltage	DC-link voltage is under the voltage limits defined. • most probable cause: too low a supply voltage • AC drive internal fault • defect input fuse • external charge switch not closed Fault ID: 80 = Fault 81 = Alarm	In case of temporary supply voltage break reset the fault and restart the drive. Check the supply voltage. If it is adequate, an internal failure has occurred. Contact the distributor near to you.
12		Brake chopper supervision	• no brake resistor installed • brake resistor is broken • brake chopper failure Fault ID: 110 = Hardware fault 111 = Brake chopper saturation alarm	Check brake resistor and cabling. If the these are ok, the chopper is faulty. Contact the distributor near to you.
13		Drive undertemperature	Too low temperature measured in power unit's heatsink or board. Heatsink temperature is under -10°C. Fault ID: 120 = Fault 121 = Alarm	
14		Drive overtemperature	Too low temperature measured in power unit's heatsink or board. Heatsink temperature is over 100°C. Fault ID: 120 = Fault 121 = Alarm	Check the correct amount and flow of cooling air. Check the heatsink for dust. Check the ambient temperature. Make sure that the switching frequency is not too high in relation to ambient temperature and motor load.
15		Motor stalled	Motor stall protection has tripped. Fault ID: 140 = Fault	Check motor and load.
16		Motor overtemperature	Motor overheating has been detected by drive motor temperature model. Motor is overloaded. Fault ID: 150 = Fault	Decrease motor load. If no motor overload exists, check the temperature model parameters.
17		Motor underload	Motor underload protection has tripped. Fault ID: 160 = Fault	Check load.
41		IGBT temperature	IGBT temperature (unit temperature + I_2T) is too high. Fault ID: 400 = Fault	Check loading. Check motor size. Make identification run.
51	**1051**	External fault	Digital input	
52	**1052** **1352**	Keypad communication fault	The connection between the control keypad and drive is broken	Check keypad connection and possible keypad cable

Fault code	ID	Fault name	Possible cause	Remedy
53	**1053**	Fieldbus communication fault	The data connection between the fieldbus master and fieldbus board is broken	Check installation and fieldbus master.
54	**1354** **1454** **1654** **1754**	Slot A fault Slot B fault Slot D fault Slot E fault	Defective option board or slot	Check board and slot
65	**1065**	PC communication fault	The data connection between the PC and drive is broken	
66	**1066**	Thermistor fault	The thermistor input has detected an increase of motor temperature	Check motor cooling and load. Check thermistor connection (If thermistor input is not in use it has to be short circuited)
68	**1301**	Maintenance counter 1 alarm	Maintenance counter has reached the alarm limit.	Carry out the needed maintenance and reset counter.
	1302	Maintenance counter 1 fault	Maintenance counter has reached the fault limit.	
	1303	Maintenance counter 2 alarm	Maintenance counter has reached the alarm limit.	
	1304	Maintenance counter 2 fault	Maintenance counter has reached the fault limit.	
	1305	Maintenance counter 3 alarm	Maintenance counter has reached the alarm limit.	
	1306	Maintenance counter 3 fault	Maintenance counter has reached the fault limit.	
69	**1310**	Fieldbus mapping error	Non-existing ID number is used for mapping values to Fieldbus Process Data Out.	Check parameters in Fieldbus Data Mapping menu (chapter 3.5.8).
	1311		Not possible to convert one or more values for Fieldbus Process Data Out.	The value being mapped may be of undefined type. Check parameters in Fieldbus Data-Mapping menu (chapter 3.5.8).
	1312		Overflow when mapping and converting values for Fieldbus Process Data Out (16-bit).	
101	**1101**	Process supervision fault (PID1)	PID controller: Feedback value outside of supervision limits (and the delay if set).	
105	**1105**	Process supervision fault (PID2)	PID controller: Feedback value outside of supervision limits (and the delay if set).	

Table 55. Fault codes and descriptions

3.8 Fieldbus process data out

Values to monitor through fieldbus are:

Data	Value	Scale
Process Data Out 1	Output frequency	0.01 Hz
Process Data Out 2	Motor speed	1 rpm
Process Data Out 3	Motor current	0.1 A
Process Data Out 4	Motor torque	0.1 %
Process Data Out 5	Motor power	0.1 %
Process Data Out 6	Motor voltage	0.1 V
Process Data Out 7	DC-link voltage	1 V
Process Data Out 8	Last active fault code	

Table 56. Fieldbus Process Data Out

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